INSTRUCTION AND MAINTENANCE MANUAL

LOW NOISE PREAMPLIFIER

ITHACO MODEL 1201

NOVEMBER 1980

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MANUAL CHANGES

MODEL 1201 LOW NOISE PREAMPLIFIER

Date January 15, 1980 Supplement A

Make all changes in this manual according to the Errata below. Also check the following table for your instrument serial number and make the listed changes in your manual.

MODEL	SERIAL NO	MAKE MANUAL CHANGES	MODEL	SERIAL NO	MAKE MANUAL CHANGES
1201	ALL				

CAUTION: NOT FOR USE ON HUMAN SUBJECTS

The ITHACO Model 1201 Low Noise Preamplifier was designed to meet the low level signal processing requirements in many applications, including biological studies.

However, the Model 1201 is not recommended for use on human subjects, and ITHACO expressly discourages such use.

Although safety consideration was one of the major design philosophies incorporated in the Model 1201, there is always the small chance of internal component failures.

If such failures were to occur under certain conditions with the Model 1201 connected to the patient, dangerous current levels could flow through the subject. This is especially true if the skin resistance of the subject were compromised in which case the subject would become part of a low impedance path.

The Model 1201 is, however, an excellent low noise preamplifier for use in biological studies on non-human subjects and for such studies its use can be considered consistent with an acceptable risk.

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SECTION I

INTRODUCTION

1.1 DESCRIPTION

The ITHACO Model 1201 is a low noise voltage preamplifier, capable of amplifying low level voltages from DC to 400 kHz. Voltage gain from 10 to 25,000 is provided by using the gain switch and its associated vernier control. Discrete steps in gain are provided in a 1-2-5 sequence from X10 to X10,000 and may be increased by a factor of 2.5 by using the variable gain control.

Adjustable high pass and low pass rolloffs allow the bandwidth to be easily controlled.

Input is provided via two front panel BNC's and may be either AC or DC coupled. Each input, which has its own coupling switch allows the user to operate in either the single-ended or differential input mode.

An internal battery pack is provided consisting of two rechargeable nickel cadmium 1.2A-hr. battery packs. When fully charged, they will operate the 1201 in excess of 25 hours under normal operating conditions. A battery test switch and indicator is provided on the front panel. This indicates to the operator whether the battery has sufficient voltage to operate the 1201.

Additional features include front panel adjustment of CMR and precise DC zeroing, overload recovery switch and overload indicator (monitors all critical points in the 1201). Gated operation is also provided as well as four different outputs from the 1201 (2-600 ohm, 50 ohm and X1).

With the Remote Programming Option -06, the 1201 may be interfaced to computers and programmable calculator systems. Full gain control with gain status and overload/recovery is possible. Front panel high pass and low pass filter switch settings can be read out. The Remote Programming Option -06 also allows computer-controlled gated operation.

1.2 SPECIFICATIONS

See Specifications on next page.

IPS-134

MODEL 1201 LOW NOISE PROGRAMMABLE PREAMPLIFIER

ITHACO

735 WEST CLINTON STREET ITHACA NEW YORK 14850 PHONE 607-272-7640 TWX 510-255-9307

SPECIFICATIONS

INPUT IMPEDANCE	DC Coupled: Greater than 1 gigohm (1000 megohms); typically 5 gigohms (5000 megohms). AC Coupled: 100 megohms
INPUT CURRENT	Less than 10pA, either input; less than 5pA difference (offset) current.
INPUT FREQUENCY RESPONSE	< 0.008 Hz (AC coupled)
DC STABILITY (vs. Temperature)	6μV/°C max, referred to input; 300μV/°C max, referred to output.
DC STABILITY (vs. Time)	20μV/24 hr, non-cumulative, maximum, after ½ hour warmup.
MAXIMUM INPUT, COMMON MODE	10 volts, pk-pk, minimum.
MAXIMUM INPUT, DIFFERENTIAL OR SINGLE-ENDED	±750mV (gains of X10 – X100) ±75mV (gains of X200 – X10K)
COMMON MODE REJECTION (Minimum)	Frequency / Gain > 200 / Gain < 200 DC – 100 Hz: 125 dB / 115 dB 1 kHz: 105 dB / 95 dB 10 kHz: 85 dB / 75 dB 100 kHz: 65 dB / 55 dB 200 kHz: 55 dB / 45 dB 400 kHz: 50 dB / 40 dB
GAIN	X10 to X10,000 in a 1-2-5-10 sequence; front panel potentiometer provides continuous gain to X25,000.
GAIN ACCURACY	Better than 1% when vernier is in CAL position.
GAIN STABILITY	Better than 0.03%/°C.
DISTORTION	Typically less than 0.01%.
FREQUENCY RESPONSE	DC Coupled: DC to 400 kHz (–3 dB) with low pass switch in MAX position. AC Coupled: 0.008 Hz to 400 kHz (–3 dB) with low pass switch in MAX position.
HIGH PASS FILTER (low frequency rolloff)	Switch-selectable from DC and 0.03 Hz to 3 kHz, in a 1-3-10 sequence.
LOW PASS FILTER (high frequency rolloff)	Switch-selectable from 3 Hz to 300 kHz and MAX in a 1-3-10 sequence; bandwidth in MAX position is 400 kHz minimum.
NOISE FIGURE	Less than 0.4 dB at 10 Hz, with a 1 megohm source impedance. Less than 0.04 dB at 1 kHz, with a 1 megohm source impedance.
NOISE	Less than 15 nV per Hz $^{-½}$ at 10 Hz. Less than 7 nV per Hz $^{-½}$ at 1 kHz.
OUTPUTS	Four outputs (BNC) as follows: a) 600Ω outputs (2). b) Lo-Z output (to 25 mA, 50Ω). c) Unity-gain (X1) output.
MAXIMUM OUTPUT VOLTAGE (battery operation)	a) 600Ω outputs: 12 volts pk-pk, minimum. b) Lo-Z output: 10 volts pk-pk minimum, up to 25 mA. c) Unity-gain (X1) output: 1.3 volts pk-pk minimum, up to 7 mA.
MAXIMUM OUTPUT VOLTAGE (line operation)	a) 600Ω outputs: 20 volts pk-pk, minimum. b) Lo-Z output: 18 volts pk-pk minimum, up to 25 mA. c) Unity-gain (X1) output: 2 volts pk-pk, minimum, up to 7 mA.
GATED OPERATION	Preamplifier may be gated with external input (rear panel BNC). Any waveform type, including TTL or contact closure, is permissable. Minimum duration (pulse) is 20μsec.
REMOTE PROGRAMMING	Option (user-installable) inputs permit remote control of gain (from X10 to X10,000 in a 1-2-5-10 sequence), overload recovery and gating. Gain and/or overload may be latched. Device select function line allows multiplexing several Model 1201 Preamplifiers. Option outputs indicate remote operation, incorrect gain command, gain status, gain un-CAL, overload, low pass filter status and high pass filter status. Format is BCD-coded.

1.3 1201-06 INITIAL CHECKOUT - REMOTE PROGRAMMING OPTION

As shipped, the 1201-06 Remote Programming Option will have no effect on the 1201 operation. However, if connections are made to the rear panel connector, the option may take control, and some confusing situations may result. Therefore, the following check out procedure is recommended to help gain familiarity with this option, and to check its functionality.

NOTES: When making connections to the OPTION Connector, use the mating connector supplied or other suitable means to avoid damaging the 1201.

- CAPITAL LETTERS indicate items on the 1201.
- PIN numbers refer to the Rear Panel OPTION connector.

PROCEDURE

1. Remove any connectors to the OPTION and GATE connectors.

2. Check the function of the 1201 per section 3.3.5.

3. Connect test equipment to the 1201 as shown in Figure 1.3.1.

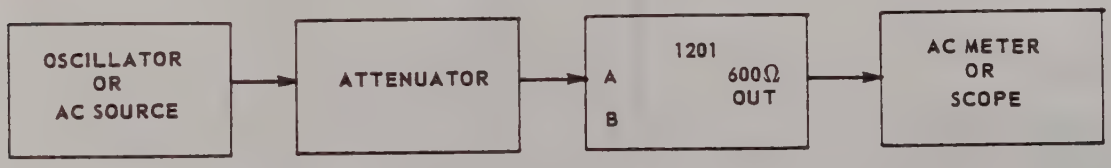


FIGURE 1.3.1 Initial Test Setup

4. Set 1201 controls

VAR GAIN	: CAL
GAIN	: 10
INPUT A	: AC
INPUT B	: GND
HIGH PASS	: DC
LOW PASS	: MAX
POWER	: ON
BATTERY	: C/25-LINE

Observe a gain of 10 by using the external oscillator/attenuator and meter or scope. The OVLD indicator should be unlit.

5. INTERNAL PULLUPS

Check the DC Voltage at PIN 36 (GCE2) on the option connect for about +5V (input selector set to INT). Likewise, check PIN 18 ($\overline{\text{OVLD}}$) for about +5V (output selector set to INT).

6. POWER-ON DEFAULT (GAIN)

Switch GAIN to "R" (remote). Gain should still be 10 (power up default state). If not, try turning power off momentarily.

7. OVERLOAD OUTPUTS

Change GAIN to 20 causing 1201 to overload. Note that the voltage at PIN 18 ($\overline{\text{OVLD}}$) goes low ($\approx$0 VDC) and PIN 17 (OVLD+$\overline{\text{DSEL}}$) goes high.

8. OVERLOAD RECOVERY

Temporarily connect PIN 30 ($\overline{\text{RECY}}$) to ground (PIN 9), and observe that the overload condition goes away.

9. GATE CONTROLS

a. Reduce GAIN to 10, eliminating Overload.
b. Short the GATE INPUT BNC, and observe that the 1201 gain has gone to zero.
c. Connect PIN 31 ($\overline{\text{GOR}}$) to ground. Observe that the option "Gate OverRide" has defeated the rear panel GATE INPUT function, and that:
d. When PIN 32 (GATE) is now grounded, the 1201 gain goes to zero. The "Gate Override" has given control to the GATE input.
e. Remove the connection to PIN 31 ($\overline{\text{GOR}}$), and observe that PIN 32 (GATE) no longer has control.

10. RECOVERY AND GATE CONTROL LATCH

a. Ground PIN 31 ($\overline{\text{GOR}}$) and PIN 32 (GATE). 1201 Gain has now gone to zero.
b. Ground PIN 36 (GCE2)-Gain Change Enable, and observe that no combination of inputs at PINS 31, 32 or the GATE INPUT BNC now have any effect.
c. Remove all PIN connections.
d. Change GAIN to 20, causing overload.
e. Ground PIN 30 ($\overline{\text{RECY}}$). The Overload condition has gone away.
f. Ground PIN 36 (GCE2) and note that releasing PIN 30 ($\overline{\text{RECY}}$) now has no effect.

11. POWER ON DEFAULT (GATE & RECOVERY)

a. Ground PIN 36 (GCE2), PIN 30 ($\overline{\text{RECY}}$), PIN 31 ($\overline{\text{GOR}}$) and PIN 32 (GATE). Remove any connection to GATE INPUT BNC.
b. Temporarily turn POWER off.
c. Observe that the unit is overloaded, and that grounding the GATE INPUT or pushing the OVERLOAD RECOVERY SWITCH will eliminate the overload.
d. Remove all PIN connections and GATE INPUT connection.

12. GAIN READOUT

a. Connect a display device to PINS 2, 3, 4, 5, 6, 11, 12, 13, 14, 16. PINS 7 and 15 may also be monitored. The circuit in Figure 1.3.2 is recommended if nothing else is available.

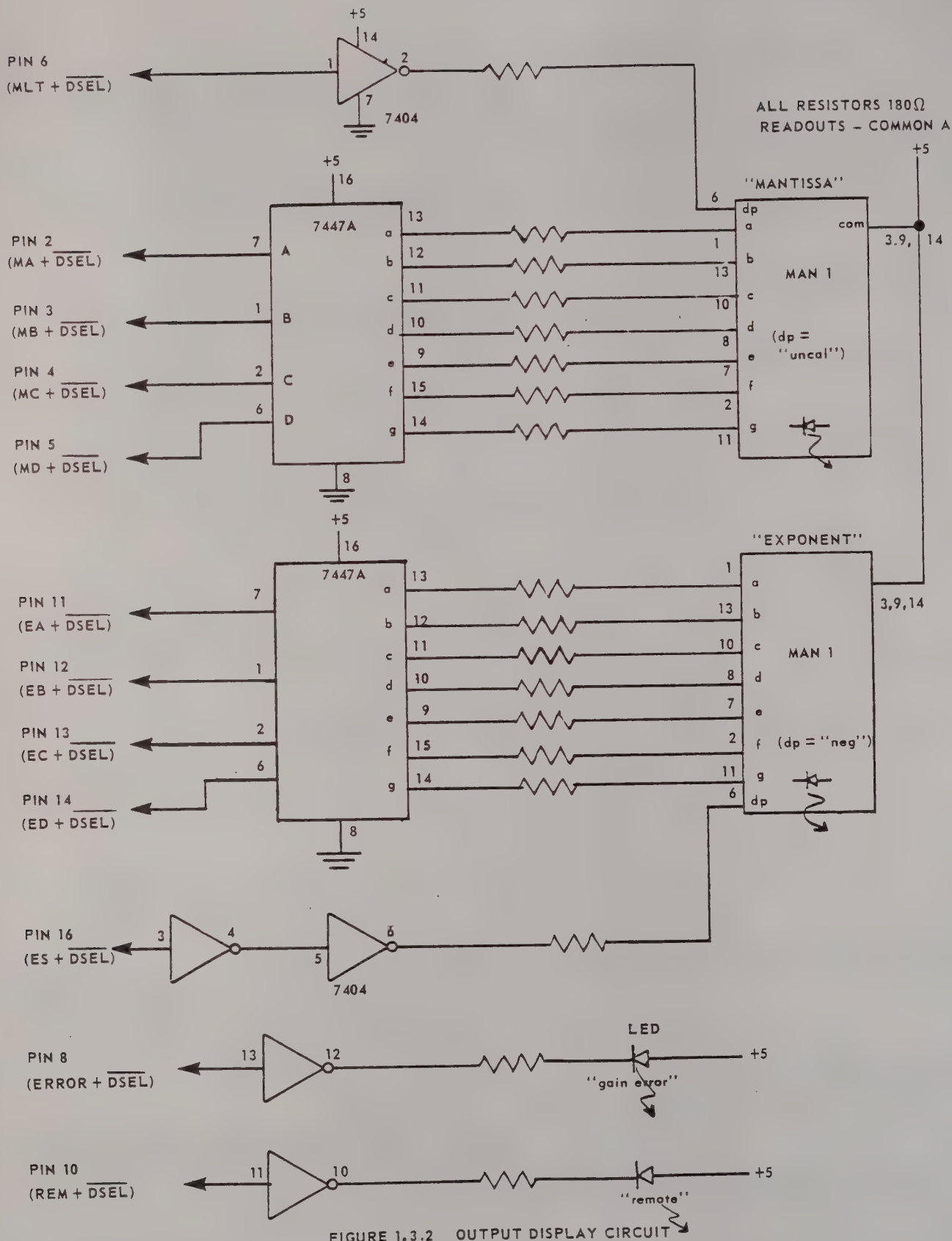


FIGURE 1.3.2 OUTPUT DISPLAY CIRCUIT

b. Set GAIN to 20, and observe the display. The "Mantissa" readout will be "2" and the "Exponent" readout will be "1", indicating a gain of 2×10^1 or 20. The "Uncal" and "Neg" readouts will be off. Ignore the "gain error" light.
c. Change the GAIN throughout its range and verify that the display represent the GAIN setting.
d. Rotate the VARIABLE GAIN CONTROL and note that the "uncal" light turns on.

13. SWITCH READOUTS

a. Ground PIN 27 (SEL 1). HIGH PASS is now SELected. Observe that the display reads "00" ("DC").
b. Change HIGH PASS to .03. The display should now read 3.2 indicating 3×10^{-2}.
c. Continue through other HIGH PASS settings.
d. Note that the position of the VARIABLE GAIN CONTROL has no effect on the "uncal" display.
e. Remove wire to PIN 27 (SEL 1) and Ground PIN 28 (SEL 2). The LOW PASS is now SELected and the display will be "00" indicating "MAX".
f. Rotate the LOW PASS SWITCH through its other settings and observe the correct display.

14. IDENTITY READOUT

Ground PIN 27 (SEL 1) and PIN 28 (SEL 2). The display will now read "01" indicating model 1201.

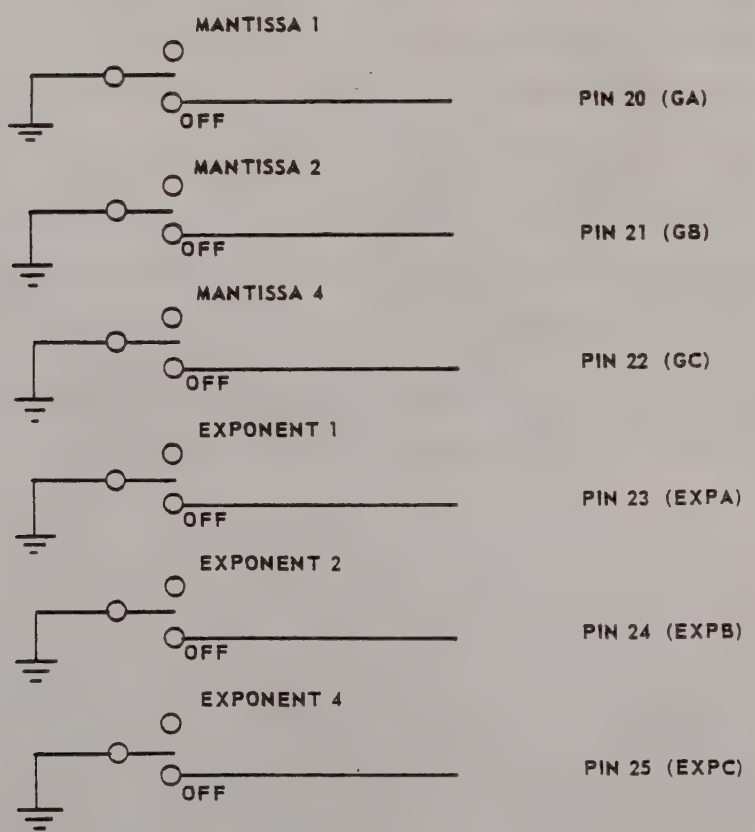


FIGURE 1.3.3 GAIN INPUT SWITCHES

15. GAIN CONTROL

a. Return the 1201 to the original settings. (PROCEDURE St
b. Connect switches to the GAIN CONTROL INPUTS (PINS 20, 21, 22, 23, 24, 25) per Figure 1.3.3 or use an equivalent circuit.
c. Observe that the display reads "11" and ignore the "gain error" light. Note that the "remote" light is off.

d. Change the GAIN to "R" and set the remote switches to:

MANTISSA			EXPONENT		
4	2	1	4	2	1
OFF	OFF	ON	OFF	OFF	ON

Note that the display reads "11", the "error" light is off, and the "remote" light is on. Use the attenuator scope, etc. to verify that the 1201 gain is 10.

e. Sequence through remote switches and note the followin results (only on states are shown).

MANTISSA			EXPONENT			DISPLAY	ERROR	REMOTE	1201 GAIN
4	2	1	4	2	1	---	---	---	---
	ON				ON	21	(OFF)	ON	20
ON		ON			ON	51		ON	50
		ON		ON		12		ON	100
	ON			ON		22		ON	200
ON		ON		ON		52		ON	500
		ON		ON	ON	13		ON	1000
	ON			ON	ON	23		ON	2000
ON		ON		ON	ON	53		ON	5000
		ON	ON			14		ON	10000

16. GAIN ERROR DETECTOR

Enter the following combinations on the switches and note that the "error" light is on for each. Ignore any strange effects this may have on gain or display readings. This is only a partial listing.

MANTISSA			EXPONENT			ATTEMPTED GAIN
4	2	1	4	2	1	
(OFF)	(OFF)	(OFF)	(OFF)	(OFF)	(OFF)	0
		ON				1
	ON					2
ON						4
	ON	ON			ON	30
ON					ON	40
ON	ON	ON			ON	70
ON				ON		400
ON	ON			ON		600
ON	ON	ON		ON		700
	ON	ON		ON	ON	3,000
ON	ON	ON		ON	ON	7,000
	ON		ON			20,000
	ON	ON	ON		ON	300,000
ON		ON	ON	ON		5,000,000
ON	ON	ON	ON	ON	ON	70,000,000

17. GAIN LATCH

a. Set the remote switches to:

MANTISSA			EXPONENT		
4	2	1	4	2	1
	ON				ON

observe that the display reads "21".

b. Connect PIN 35 (GCE1) to ground, and observe that no setting of the remote switches now has any effect on the gain. The only effect on the display will be that the "gain error" light will still be functional.

c. Go back to condition 17a.

d. Change Mantissa 4 switch to "ON". Note that the display still reads "21" and that the gain has not changed.

e. Rotate the GAIN SWITCH from "R" to other gain settings. The display and preamp gain will follow the GAIN SWITCH The "gain error" light will stay with the setting on the remote switches.

f. Return the GAIN SWITCH to "R". Note that the display has returned to "21".

g. Disconnect PIN 35 (GCE1) from ground.

18. DEVICE SELECT LINE

a. Set the GAIN SWITCH to "100". Adjust attenuator for no overload on 1201.

b. Set remote switches to condition at step 17a. (GAIN=20)

c. Connect PIN 34 (DSEL) to ground.

d. Note following conditions:

display	BLANK (except dp)
"gain error"	ON
"remote"	ON
"uncal" (dp)	ON
"neg" (dp)	OFF

voltage at PIN 17 ($\overline{OVLD}$+$\overline{DSEL}$) is $\approx$5VDC
voltage at PIN 18 ($\overline{OVLD}$) is $\approx$5VDC

e. Sequence remote switches through:

MANTISSA			EXPONENT		
4	2	1	4	2	1
	ON				ON
	ON			ON	ON
ON	ON			ON	ON

f. Change GAIN SWITCH to "R".

g. Recheck condition in 18d. All should be the same except PIN 18 which will now be $\approx$0 VDC.

h. Disconnect ground from PIN 34 (DSEL) and observe that the display reads "21" (not "23"):

i. A similar exercise can be done to show that the Gate Control and Overload recovery lines are inactive when DSEL is low.

SECTION 2

INSTALLATION

2.1 INSPECTION

2.1.1 GENERAL

Before shipment, the Model 1201 was found to be free of electrical and mechanical defects. As soon as the instrument is unpacked, inspect for any damage that may have occurred in transit. Save all packing material until the inspection is complete. If damaged in any way, a claim should be filed with the carrier and a copy forwarded to ITHACO. ITHACO will then advise you as to the disposition of the equipment and will arrange for repair or replacement of the equipment without waiting for a settlement of a claim against the carrier.

2.1.2 VISUAL INSPECTION

A visual check should be made to confirm that there are no broken knobs or connectors, that the case and panel surfaces are free of dents and scratches and that the frame, transformer, battery pack and bail assembly are undamaged.

2.1.3 ELECTRICAL INSPECTION

The instrument should be checked againsts its electrical specifications (see Section I).

2.2 INSTALLATION

The 1201 Low Noise Preamplifier needs only to be connected to a power source for normal bench top use. See Section 2.3, "Power and Grounding".

For those installations where rack mounting is desired, two rack mounting kits are available: Model RM-1 for two 1201's side by side; Model RM-2 for a single 1201 in a 19" rack.

2.3 POWER AND GROUNDING

Unless otherwise specified, all units are shipped with a six foot, three conductor power cord equipped with a grounded plug. Normally, the 1201 should be connected to a grounded power source.

Before connecting the 1201 to the line, check that the line voltage switch (inside rear panel connector) is in the proper position.

50-400 Hz Setting	Voltage Range	Recommended Slo-Blow Fuse
100	90-110 VAC	0.25A
120	105-130 VAC	0.25A
220	195-240 VAC	0.125A
240	210-260 VAC	0.125A

To change the power setting, first turn off the unit. Remove the power cord and slide the plastic window to one side. Remove the fuse by pulling out on the "fuse pull" lever. Remove the small printed circuit board by hooking a stiff wire in the hole at the rear of the board and pulling straight out. Select the proper voltage setting from the above table and orient the board so the desired setting will be visible through the window when the board is reinserted. Reinsert the board in the desired orientation, install the proper fuse and push the "fuse pull" lever back. Slide the window back and reconnect the power cord

For battery operation, see Section 4 "Battery Operation and Maintenance".

SECTION 3

OPERATING INSTRUCTIONS

3.1 GENERAL

The ITHACO Model 1201 is a powerful laboratory instrument for use wherever low level, low noise signal processing is required. The following paragraphs outline general operating instructions for the 1201.

For a "quick glance" description of all the controls, inputs and output connections, refer the Figure 3.1. A detailed description of each function and control is treated in Section 3.3.

3.2 INITIAL CHECKS

As a "get acquainted" exercise, set the amplifier up in the following test setup (Figure 3.2). Set the controls to the following settings:

Rear Panel Power Setting	consult Section 2.3 for proper power setting
Batt, C/10, C/25 (rear panel)	C/25
Gain	X10, CAL
Low Pass	MAX
High Pass	DC
Input A (AC-GND-DC)	DC
Input B (AC-GND-DC)	GND
On/Off	OFF

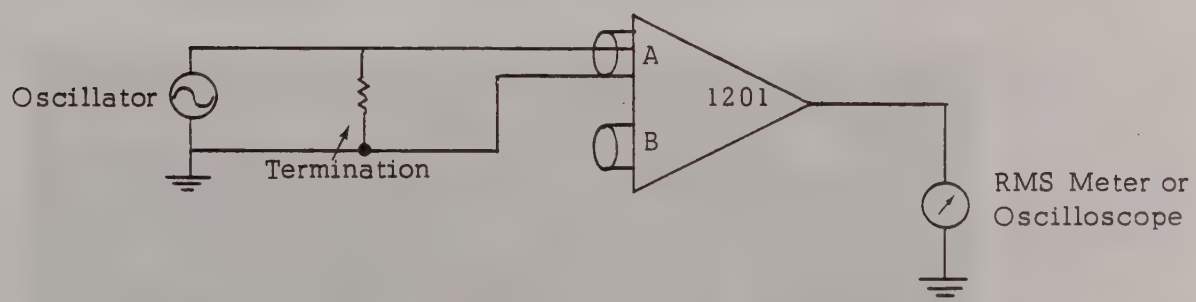
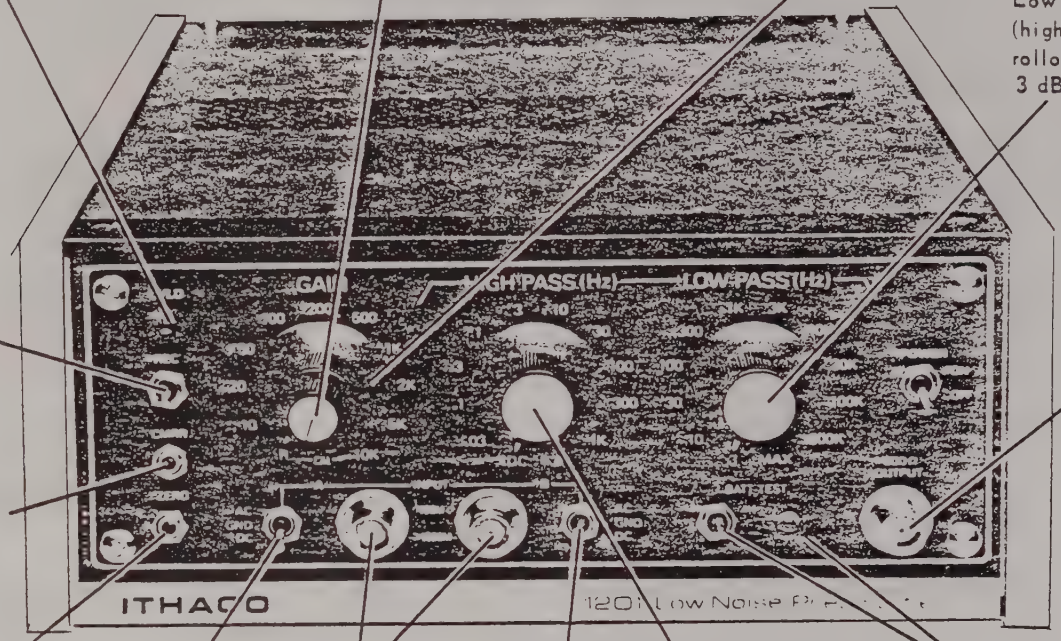


Figure 3.2

After verifying that your power source is correct, turn the unit "ON". Set the oscillator to 1 kHz, 0.1 volt rms. The 1201 should be providing a clean, 1 kHz, 1 volt rms signal at the 600 ohm and low-Z outputs and a 0.1 volt rms



Overload indicator (all critical circuit points)

Vernier gain for continuous control to 2.5X gain switch setting

Gain switch for 1–2–5–10 gain sequence

Low pass filter (high frequency rolloff) control 3 dB point

Manual switch for overload recovery

Adjustment for common mode rejection ratio

J3
600–ohm output (parallels rear panel 600–ohm output)

Adjustment for precise DC zeroing

Input Coupling Switches

Inputs with selectable true differential or single–ended modes, DC and/or AC coupling

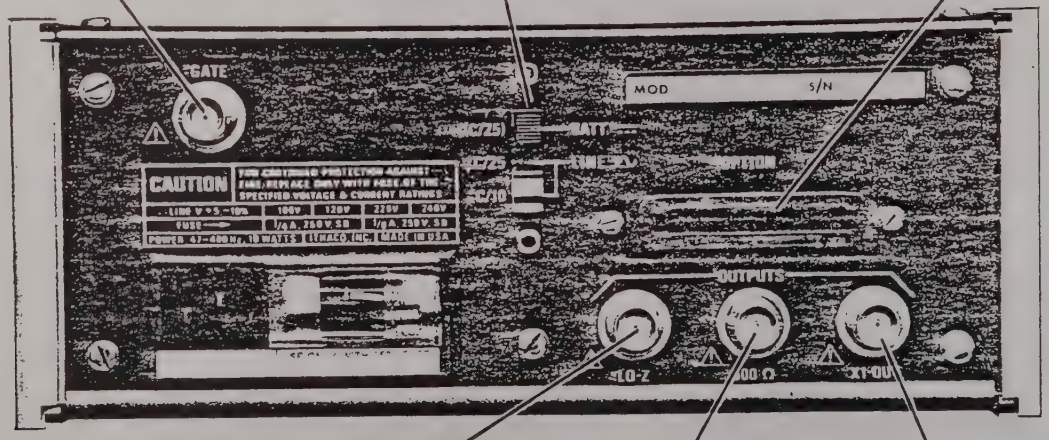
High pass filter (low frequency rolloff control) 3 dB point

Battery test switch indicator (green indicates adequate charge)

Input for external gating signal (or closure) With BNC open, 1201 operates in Normal mode. With gate input grounding (≤0.8V) 1201 signal path is opened.

Battery charge rate selector switch
C/25 Slow Charge Rate
C/10 Fast Charge Rate

Remote programming option inputs/outputs



J11
Low impedance (50 ohm) output up to 25mA at any gain and over total frequency range.

J12
600–ohm output (parallels front panel 600–ohm output)

J13
Unity–gain (X1) output up to 7mA over total frequency range

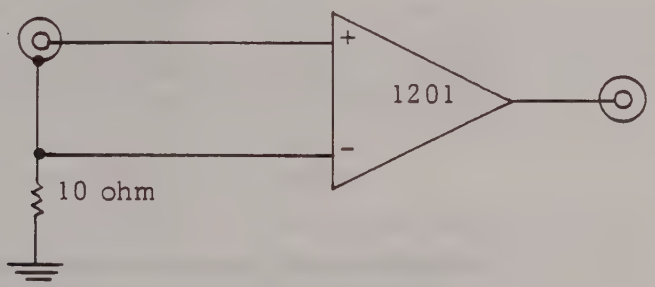
FIGURE 3.1

signal at the X1 output. At this point, it is recommended the user explore the functions of the various controls, as well as experiment with other frequencies and amplitudes. This will give a good feel for the operation of the 1201.

3.3 CONTROLS AND INDICATORS

3.3.1 INPUT SWITCHES

The following figures represent various combinations of input switch configurations and a simple diagram of how they effect the input section of the 1201. The two inputs operate in an essentially identical manner. The A input will provide output signals which are, for moderate frequencies, in phase with the input signals. The B Input is the inverting input, i.e., the 1201 output will be 180° out of phase with the input.



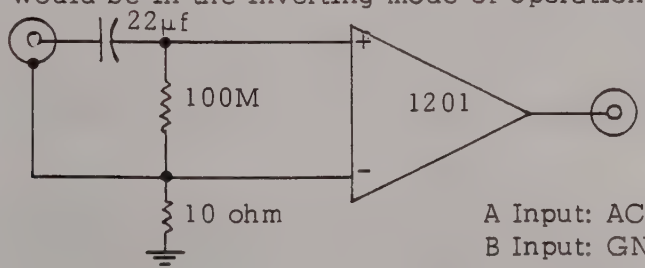
A Input: DC
B Input: GND

Figure 3.3

Figure 3.3 shows the 1201 in the single-ended, non-inverting, configuration.

The shields of the input BNC's are isolated by 10 ohms from the 1201 signal ground, which provides a high degree of ground loop immunity.

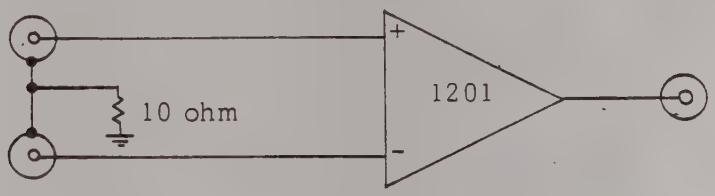
If the input switching arrangement were reversed, i.e., A Input: GND and B Input: DC, the operation of the 1201 would be identical except one would be in the inverting mode of operation.



A Input: AC
B Input: GND

Figure 3.4

The Figure 3.4 shows the 1201 in the AC coupled mode. This mode is useful in measuring AC signals in the presence of DC voltages up to 200V.



Both Inputs at DC (differential mode)

Figure 3.5

Figure 3,5 shows the 1201 in the differential input mode. In this mode, the output voltage is simply:

E_{out} = (A - B) X (1201 Gain)
where A = voltage applied to A Input
B = voltage applied to B Input

The differential mode is extremely useful and has many applications. One common application is illustrated in Figure 3.6.

The 1201 output will be zero, indicating null, when the bridge is balanced. This experiment takes maximum advantage of the differential input and common mode features of the 1201.

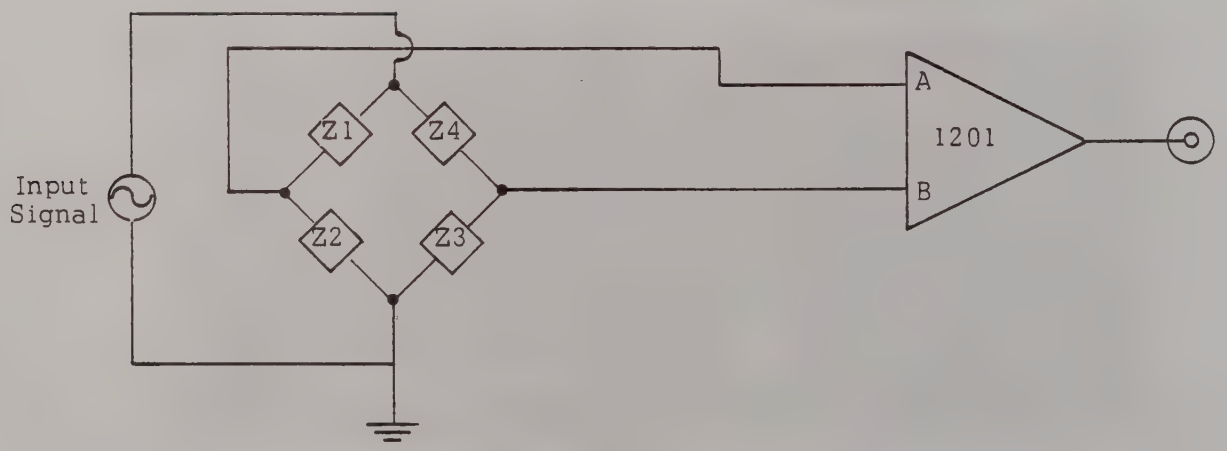


Figure 3.6

3.3.2 HIGH PASS FILTER

The high pass filter switch selects frequencies from DC to 3 kHz in a 1-3-10 sequence. The high pass filter attenuation is -6 dB/ octave. The most counterclockwise position allows dc voltages to be amplified. At the frequency selected, the output will be 3 dB down (0.707), except, of course, in the DC positon.

3.3.3 LOW PASS FILTER

The low pass filter switch selects frequencies from 3 Hz to 300 kHz in a 1-3-10 sequence. Frequency response in the "MAX" position is at least to 400 kHz. The low pass filter attenuation is -6 dB/octave.

The high pass filter and low pass filter switches may be selected to reduce hum in the output, to reduce high frequency noise, as a bandpass to allow only one frequency through or in any other application where full bandwidth is not desired.

3.3.4 GAIN

Voltage gain from 10 to 25,000 may be selected using this switch and its associated variable control. Discrete steps in a 1-2-5-10 sequence from X10 to X10,000 are selectable and each step may be increased up to a factor of 2.5 using the variable gain control.

Gain accuracy is specified ±1% with the vernier in the CAL position.

Gain switching may also be accomplished with the -06 Remote Programming Option. The Remote Programming Option is selected by placing the gain switch in the "R" position. When not in the "R" position, the gain is determined by the gain setting selected, and overrides any input to the RPO.

When no Remote Programming Option is installed and the gain switch is in the "R" position, the gain stages go to low gain and the internal signal path becomes open so that little or no signal appears at any output (except the X1 output).

3.3.5 GATING

When the gate BNC on the rear panel is left open, the gating circuit is inactive and signals pass normally from input to output. When the gate input is grounded (0V up to approximately 0.8V), the gating circuit is activated and interrupts the signal path, preventing an active output.

The X1 output is excepted from this switching, as the amplifier is supplied from the factory. If it is desired to gate the X1 output, remove the jumper from terminals AA to BB on the Motherboard A3. Reconnect the jumper from terminal AA to terminal CC. In this position, the X1 output is also gated.

The gating feature is especially useful when strong overloading signals are present at the amplifier input at a predetermined time. For example, a strong transmitted pulse can be prevented from overloading the filters and the output amplifier when the 1201 is connected to receive an echo pulse through a transducer.

3.3.6 BATTERY SWITCH (BATT, C/25, C/10)

C/25 — The amplifier will probably be received from the factory with the switch in this position. With the line cord plugged in, the internal batteries trickle-charge. The 1201 electronics operate from the internal power supply.

C/10 — The batteries charge at the fast rate in this position. This instrument is provided with cooling holes but the user should not charge the batteries at C/10 (fast rate) for long periods at an unusually high ambient temperature or if the case has no air circulation. The build up of heat inside the case may shorten battery life. See Section 4.

In both C/25 and C/10 positions the batteries charge at the selected rate provided the line cord is connected to a power source. The amplifier receives power from the internal power supply.

BATT — In this switch position the batteries charge at the C/25 (slow) rate provided the line cord is connected to a power source. The amplifier receives power from the batteries, whether or not the line is plugged in.

To prevent excessive battery drain when operating in battery mode, do not operate for long periods of time with the overload light turned on with the inputs open in DC position or with the overload switch depressed (the contact is momentary). Also, try to avoid high load currents on the outputs, as this will reduce battery life.

3.3.7 BATTERY TEST

The Battery Test light illuminates when the BATT test switch is operated and the battery voltages are at 11.2 volts or more.

In the + position, the light indicates positive amplifier battery condition and in the - position the light indicates negative amplifier battery condition.

The battery test light does not indicate the amount of battery charge, only whether there is a voltage over 11.2 volts. Therefore, the lamp will light even though the batteries are approaching the end of their

useful charge life. To insure adequate battery charge after receipt from the factory, charge overnight before using at the C/10 rate. The batteries will charge at the selected rate even with the power switch off as long as the line cord is connected to a power source. See Section 4.

3.3.8 OVERLOAD LIGHT

The overload indicator lights when a voltage peak or a DC voltage exceeds the specified maximum value at any of three different points in the 1201. A detector after the first gain stage, one after the second gain stage and a detector for excessive common mode signal operates to turn on the light. A small hysteresis is built into the detector circuit so that the overload signal must be reduced below the level required to turn on the light, in order to turn the light off.

If an unexplained overload occurs, check the input signal first. Next check the input switch positions. If one channel is left unconnected with the input switch in DC position, the amplifier input currents may cause overload. Switch to ground (center position).

When operating in AC coupled mode, the instrument time constants are 22 seconds at the input and 5 seconds maximum at the high pass filter output. A momentary overload may require some time to clear itself. This may be speeded up by operating the overload recovery switch which decreases the time constants at both of these locations.

3.4 OUTPUTS

At the front panel output, J3, the output impedance is 600 ohms and it is tied to the same point as output J12 on the rear panel (two separate 600 ohm resistors). The Lo-Z output, J11 on the rear panel is also tied to the same point as J3 and J12. However, this connection is made through an internal 49.9 ohm resistor. Pads are provided on the printed circuit board for adding a resistor in series with the X1 output, J13, if desired. Simply cut the jumper between the pads and add the desired resistor in place of the jumper. Facing the unit from the front, the existing jumper is located on the extreme left hand rear corner of the main P.C.board, next to pin 61.

The X1 output on the rear panel is not connected to any other outputs. It is connected to the output of the first gain stage of the amplifier and therefore is not controlled by either the high pass or low pass switch, the gain switch, or the gating circuit. This output will be the same as the differential input, within the bandwidth limitations of the first stage.

3.5 1201-06 REMOTE PROGRAMMING OPTION

3.5.1 GENERAL DESCRIPTION OF CAPABILITIES

The 1201-06 Remote Programming Option is a general purpose interface for the 1201 which allows the user to control and read out many of the functions of the preamp. The capabilities of this option are listed below with a brief description of each function. More detailed information is available in the later sections (3.5.2 thru 3.5.3) and in the checkout procedure (section 1.3).

3.5.1.1 Control Functions

Through separate control lines, the user can remotely control Gain, overload recovery and gating.

When the front panel Gain Switch on the 1201 is set to "R", six control lines (two groups of three) allow remote control of the 1201 gain in discrete steps corresponding to those available on the front panel. The input lines are coded in binary (equivalent to BCD in this case) with 3 lines representing the Mantissa and 3 lines representing the Exponent. An error detector identifies invalid inputs and creates an "error" output in return. The 1201 will not try to execute invalid gain commands.

Overload recovery is effected through the use of one independent line. A low input on this line will activate the overload recovery function in the 1201. Operation of this line is in parallel with the front panel control.

The gating function in the 1201 is arranged so that it can be performed either at the rear panel GATE INPUT BNC or at the option input connector. One control line transfers gate control between the GATE INPUT BNC and the option. When the option is controlling the gate function, a second line determines whether the gate is on or off. When the gate is not controlled by the option, the GATE INPUT BNC functions normally. Refer to section 3.3.5 for normal operation of the 1201 gate.

3.5.1.2 Readout Functions

The 1201-06 is set up to read out most functions in the 1201. These include: gain status, high pass switch and low pass switch status, overload condition, remote gain control state, and gain input command error.

The readout functions are divided into two groups; multiplexed and nonmultiplexed. For efficient use of lines, all outputs except for gain error, overload and remote status, which have independent output lines, are multiplexed. The gain error output (discussed previously) indicates when the user is trying to execute an impossible gain command, while the remote status line indicates when the 1201 Gain Switch is in the "R" position (and the 1201 is under remote gain control).

When the analog signal levels go outside of the linear operating range, an Overload indication is provided on two lines. One line goes to a high state when a 1201 overload occurs, while the other line goes to a low state on overload. The negative logic output allows the use of wired "OR" connections in a multiple instrument system - more on this later.

All of the remaining output signals are multiplexed onto eight lines. On these lines, the following conditions can be read out: gain, gain uncalibrated, low pass setting, high pass setting, and 1201 identification. Coding on these lines is in positive-true Binary Coded Decimal (BCD) format. These are broken down as follows:

3 lines - Mantissa of Value
1 line - Value uncalibrated
3 lines - Exponent of Value
1 line - Sign of the Exponent

In order to select which function will be present at the outputs, two control lines are used as selectors.
Gain - when both selector lines are high (normal state), the output lines indicate the gain status of the 1201. At this time, the "uncalibrated" line indicates the status of the 1201 GAIN VERNIER POT. It should be noted that this gain output is the actual gain of the 1201, which may be different from the remote gain command on the gain control inputs.

High pass - when the first selector line is pulled low, the value on the output lines will represent the HIGH PASS SWITCH setting. This value translates directly to the 3dB cutoff frequency in Hertz except for the "DC" position which gives a value of Zero.

Low pass - when the second selector line is pulled low, the value on the output lines now represents the setting of the LOW PASS SWITCH. This again represents the 3dB cutoff frequency with the "MAX" position represented by a value of Zero.

1201 Identity - when both selector lines are pulled low, a value of 0 appears on the Mantissa and 1 appears on the exponent indicating a 1201 preamp.

3.5.1.3 Latching and Bussing

Several features are provided in the 1201-06 to aid in systems implementations. The most important of these is the "Device-Select Line" which allows parallel bussed and multiplexed operation of several 1201 amplifiers. When the device select line is pulled low, first, all control inputs are latched, and then all further changes on the input lines are ignored. This allows the system to talk to other 1201's which are connected to the bus. At the same time, all outputs except for the negative logic "Overload" output go to a high impedance state (15KΩ) allowing other 1201's to talk to the bus. Up to ten 1201's may be paralleled in this manner.

Another feature of the 1201-06 is the ability to perform parallel interrupt and serial polling of the overload condition. In a multiple amplifier system, the two overload output lines can be bussed between several amplifiers allowing one line to perform the interrup function. When the system senses a low state on this line, it then can poll each amplifier on the other line to locate the overloaded instrument.

A third feature is the ability to latch the input data, in two groups, independently of the multiplexing. The two "Gain-change-enable" inputs allow the user to observe data on the output lines with the input data latched (otherwise not possible when multiplexing complete instruments). This also allows the user to bring data in in 8 bit words which simplifies use with a microprocessor.

In addition, the 1201 is capable of powering up in a Known state whenever the Gain-change-enable lines or the device-select line is active. The default values for the control functions are as follows:

GAIN	10
GATE CONTROL	Rear Panel BNC
Overload Recovery	inactive

Also, to give flexibility when interfacing to various Logic families, the user is able to choose both the input and output pullup voltages. Internal jumpers are provided which can easily be moved allowing a choice of an internal 5V pullup potential or an external, user supplied pullup potential. The external pullup voltage can be any voltage between 0 and +15VDC.

⚠ WARNING: Because of possible shock and fire hazards, these jumpers should only be moved by a qualified technician.

3.5.1.4 Input/Output Line Requirements

Depending on which functions are used, the number of Input/Output lines required will vary. Below is a list of some normal arrangements and the number of lines required. Note that the "remote" line is not essential, since the input and output can be compared to determine this condition.

☐ Blank	= no
Y	= yes
( )	= required

Configuration	Gain Control	Gate Control	Recovery Control	Gain Readout	HP/LP Readout	Multiplexed	8 Bit Words	Remote Output	Overload Output	Serial Poll of Overl	Gain Error Output	Total # of Lines Required
Normal Minimum	Y	Y	Y	Y	Y				Y			18
Readout Only				Y	Y			Y	Y			10
Gain Control Only	Y											6
Full Control Only	Y	Y	Y									9
Normal Multiplexed Minimum	Y	Y	Y	Y	Y	Y			Y			19
"Adders" "Remote" Output								Y				+1
Serial Poll of OVLD						(Y)			(Y)	Y		+1
Gain Error Output	(Y)										Y	+1
8 Bit Input Words	(Y)	(Y)	(Y)				Y					+2
MAXIMUM	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	24

3.5.2 DESCRIPTION OF CONTROL LINES & FUNCTIONS

This section is broken up into sections which discuss the various input and output lines and describe requirements to make the option function. Refer to Table 3.1 for a brief listing of signal lines and their functions.

3.5.2.1 Control and Latching Lines

These are the nine input lines which are directly responsible for control of 1201 functions and the two lines which enable the input latches.

Gain Inputs and Gain change enable input (PINS 20 to 26 and 35)
The gain input lines which are coded in a Mantissa/exponent format supply the value which is stored in the gain input latch. Since there are only three lines for either the Mantissa or the exponent, the inputs can be considered to be coded in either Binary or BCD.

This is shown graphically in table 3.2. Note that PIN 26 (EXPS) is completely ignored by the 1201-06 option.

In order for this value of gain to enter in the gain input latch, the following conditions must be true:

PIN 35 (GCEl) = 1 (TRUE)
PIN 34 (DSEL) = 1
The gain represented by the inputs must be a valid 1201 gain.

If these conditions are not met, the new value will be blocked from entering the gain input latch, and the old value will remain there.

TABLE 3.1

1201-06 INPUT/OUTPUT LINES

J1 PIN #	MNEMONIC	FUNCTION	VALUE WHEN HIGH
1	V_{OUT}	User supplied output pullup Voltage	15VDC MAX
2	MA+$\overline{DSEL}$	Mantissa Output, least significant bit	1
3	MB+$\overline{DSEL}$	Mantissa Output, 3rd significant bit	2
4	MC+$\overline{DSEL}$	Mantissa Output, 2nd significant bit	4
5	MD+$\overline{DSEL}$	Mantissa Output, most significant bit	8
6	MLT+$\overline{DSEL}$	Mantissa Output, uncalibrated	not used uncal.
7	MS+$\overline{DSEL}$	Mantissa Output, sign	(+)
8	ERROR+$\overline{DSEL}$	Gain error output	command error
9	DIG GND	Digital ground	---
10	REM+$\overline{DSEL}$	Remote status output	remote gain
11	EA+$\overline{DSEL}$	Exponent Output, least significant bit	x 10
12	EB+$\overline{DSEL}$	Exponent Output, 3rd significant bit	x 100
13	EC+$\overline{DSEL}$	Exponent Output, 2nd significant bit	x 10,000
14	ED+$\overline{DSEL}$	Exponent Output, most significant bit	not used
15	EE+$\overline{DSEL}$	Exponent Output	not used
16	ES+$\overline{DSEL}$	Exponent Output, sign	(+)
17	OVLD+$\overline{DSEL}$	1201 Overload Output, multiplexed	overload
18	$\overline{OVLD}$	1201 Overload Output, unmultiplexed	no overload
19	VIN	User supplied input pullup Voltage	15VDC MAX
20	GA	Gain Mantissa input, least sig. bit	1
21	GB	Gain Mantissa input, 2nd sig. bit	2
22	GC	Gain Mantissa input, most sig. bit	4
23	EXPA	Gain Exponent input, least sig. bit	x 10
24	EXPB	Gain exponent input, 2nd sig. bit	x 100
25	EXPC	Gain exponent input, most sig. bit	x 10,000
26	EXPS	Gain exponent sign	not used
27	SEL 1	Selector inputs (control use of	see Table
28	SEL 2	output lines)	3.Y
29	SEL 4		

TABLE 3.1 (Con't) 1201-06 INPUT/OUTPUT LINES

J1 PIN #	MNEMONIC	FUNCTION	VALUE WHEN HIGH
30	$\overline{\text{RECY}}$	Overload recovery input	inactive
31	$\overline{\text{GOR}}$	Gate override input	gate control at GATE BNC
32	GATE	Remote gate control input	1201-normal Function
33	----		not used
34	DSEL	Device Select input	all other inputs enabled
35	GCE1	Gain change enable input	control latches follow remote inputs
36	GCE2	Gate/Recovery change enable input	

TABLE 3.2

VALID GAIN INPUTS

Gain	Inputs: Pin Number/Name						
	22 GC	21 GB	20 GA	25 EXPC	24 EXPB	23 EXPA	26 EXPS
10	0	0	1	0	0	1	X
20	0	1	0	0	0	1	X
50	1	0	1	0	0	1	X
100	0	0	1	0	1	0	X
200	0	1	0	0	1	0	X
500	1	0	1	0	1	0	X
1K	0	0	1	0	1	1	X
2K	0	1	0	0	1	1	X
5K	1	0	1	0	1	1	X
10K	0	0	1	1	0	0	X

1 = HIGH
0 = LOW
X = DON'T CARE

In the event that either PIN 35 (GCE1) or PIN 36 (DSEL) is low, the gain inputs will have no effect on the latch. Also, if the previously mentioned conditions are not present when 1201 power is turned on, the latch will power-up with a value of 10. Note that if no connection is made to the option, the internal pullups on the gain inputs will cause an invalid gain input, resulting in a value of 10 to be stored in the latch.

The latching of gain inputs just discussed is totally independent of the front panel GAIN switch. This means that the front panel GAIN switch can be in any position while data is being transferred into the latch. The actual gain of the 1201, however, is controlled by the front panel, and is equal to the value in the latch only when the GAIN switch is in the "R" position.

GATE/Recovery Control and Enable Lines
(PINS 30, 31, 32, 36)

The gate and (overload) recovery inputs are latched in a similar manner to the gain inputs In order to change the value stored in these latches, the following conditions must be true:

PIN 36 (GCE2) = 1
PIN 34 (DSEC) = 1

For gate operation, PIN 31 ($\overline{\text{GOR}}$) determines whether the rear panel GATE INPUT BNC or the remote gate input PIN 32 (GATE) controls the 1201 gating function. When PIN 31 ($\overline{\text{GOR}}$) is high, gating is done by the rear panel BNC; when low, gating is done by PIN 32 (GATE) input. In either case, a low input on the active gate input will turn the 1201 gain channel "off". The truth table for this operation is shown in Table 3.3. Note that when no connection is made to the option, the internal pullups cause the gate control to default to the rear panel BNC.

Overload recovery is simpler in that either the front panel switch or the remote input PIN 30 ($\overline{\text{RECY}}$) will effect overload recovery regardless of the state of each other. See Table 3.4.

If either PIN 36 (GCE2) or PIN 34 (DSEC) is low when 1201 power is turned on, the latchs will power up to a value of 1. i.e., gate control will be at the rear panel and the overload recovery function will be inactive.

3.5.2.2 Special Output Lines (PINS 8, 10, 17, 18) Refer to Table 3.5.

Gain error output PIN 8 (ERR0R + $\overline{\text{DSEL}}$)
When PIN 34 (DSEL) is high, the gain error output (PIN 8) indicates the presence of an invalid gain combination at PINS 20 thru 26. A high level at PIN 8 (ERR0R + $\overline{\text{DSEL}}$) indicates an input gain error. The functioning of this pin is not affected by either the front panel GAIN switch or the gain-change-enable input (PIN 35).

Remote Status output PIN 10 (REM + $\overline{\text{DSEL}}$)
When PIN 34 (DSEL) is high, the remote status output (PIN 10) indicates the position of the front panel GAIN switch. When the front panel GAIN is set to "R", a high level will appear at this output, indicating that the 1201 gain is being controlled by the input gain latch.

Overload Outputs PIN 17 ($\overline{\text{0VLD}}$ + $\overline{\text{DSEL}}$),
PIN 18 ($\overline{\text{0ULD}}$)
These outputs indicate whether or not the 1201 is overloaded, which corresponds directly to the indication on the 1201 front panel 0VLD light. When PIN 34 (DSEL) is high, PIN 17 ($\overline{\text{0VLD}}$ + $\overline{\text{DSEL}}$) will indicate an overload condition by a high output, while PIN 18 ($\overline{\text{0ULD}}$) will indicate an overload by a low output regardless of the state of PIN 34 (DSEL).

TABLE 3.3

GATING OPERATION

GOR PIN 31	GATE PIN 32	GATE BNC	1201 GAIN CHANNEL
1	X	1	ON
1	X	0	OFF
0	1	X	ON
0	0	X	OFF

1 = HIGH

0 = LOW

X = DON'T CARE

TABLE 3.4

OVERLOAD RECOVERY

FRONT PANEL SWITCH	$\overline{\text{RECY}}$ PIN 30	1201 OVERLOAD RECOVERY FUNCTION
ON	X	ON
X	0	ON
OFF	1	OFF

If parallel interrupt and serial polling operation is desired, simply hook all PIN 17's together, and all PIN 18's together. When an interrupt occurs (PINS 18 go low), use the device select line (PIN 34) to poll each unit, watching PINs 17 (0VLD + $\overline{\text{DSEL}}$) for an overload indication.

TABLE 3.5

SPECIAL OUTPUTS

Output Pin	DSEL Input	Output Level	High Level Indicates
ERROR + $\overline{\text{DSEL}}$ PIN 8	0	1(hi Z)	----
	1	——————>	Input Gain Error
REM + $\overline{\text{DSEL}}$ PIN 10	0	1(hi Z)	----
	1	——————>	Remote Gain Control
0VLD + $\overline{\text{DSEL}}$ PIN 17	0	1(hi Z)	----
	1	——————>	1201 Overloaded
$\overline{\text{0VLD}}$ PIN 18	X	——————>	1201 Not Overloaded

3.5.2.3 Selector inputs and shared output lines PINS 27, 28, 29 & PINS 2, 3, 4, 5, 6, 7, 11, 12, 13, 14, 15, 16

When PIN 34 (DSEL) is high, the selector inputs (PINS 27-29) determine which value is to be outputted on the shared output lines (PINS 2.....16). Refer to Table 3.6 for the input codes. Note that PIN 29 (SEL4) is active, although it is not needed for 1201 operation.

TABLE 3.6

SELECTOR CODES

Select Code	PIN 29 SEL 4	PIN 28 SEL 2	PIN 27 SEL 1	Output
0	0	0	0	Not Used (+0 x 10°, CAL)
1	0	0	1	Not Used (+0 x 10°, CAL)
2	0	1	0	Not Used (+0 x 10°, CAL)
3	0	1	1	Not Used (+0 x 10°, CAL)
4	1	0	0	1201 Identity ($+0 \times 10^{1}$, CAL)
5	1	0	1	Low Pass Switch Setting
6	1	1	0	High Pass Switch Setting
7	1	1	1	1201 Gain

Coding on the shared output lines is in BCD format, with these lines broken up into two groups; Mantissa and Exponent. The value at the output can be represented as an integer number as follows.

$$VALUE = (MANT) \times 10^{(EXP)(SIGN)}$$

where SIGN +1 for PIN 16 $(ES + \overline{DSEL})$ HIGH
-1 for PIN 16 LOW

MANT = (4 x PIN 4 + 2 x PIN 3 + PIN 2)

EXP = (4 x PIN 13 + 2 x PIN 12 + PIN 11)

Note that the effective location of the decimal point is to the right of the first (only) digit of the Mantissa. Also, when PIN 6 (MLT + $\overline{DSEL}$) is high, the value indicated above is uncalibrated.

PINS 5, 7, 14, and 15 are not used.

Tables 3.7, 3.8, and 3.9 below list all of the valid output combinations for Gain, High Pass, and Low Pass.

TABLE 3.7 GAIN OUTPUTS (Select Code 7)

1201 GAIN	PIN 4 MC+$\overline{\text{DSEL}}$	PIN 3 MB+$\overline{\text{DSEL}}$	PIN 2 MA+$\overline{\text{DSEL}}$	PIN 13 EC+$\overline{\text{DSEL}}$	PIN 12 EB+$\overline{\text{DSEL}}$	PIN 11 EA+$\overline{\text{DSEL}}$	PIN 16 DS+$\overline{\text{DSEL}}$	Abbreviated
10	0	0	1	0	0	1	1	1E1
20	0	1	0	0	0	1	1	2E1
50	1	0	1	0	0	1	1	5E1
100	0	0	1	0	1	0	1	1E2
200	0	1	0	0	1	0	1	2E2
500	1	0	1	0	1	0	1	5E2
1000	0	0	1	0	1	1	1	1E3
2000	0	1	0	0	1	1	1	2E3
5000	1	0	1	0	1	1	1	5E3
10000	0	0	1	1	0	0	1	1E4

TABLE 3.8 HIGHPASS OUTPUTS (Select Code 6)

1201 HIGHPASS SETTING	PIN 4 MC+$\overline{\text{DSEL}}$	PIN 3 MB+$\overline{\text{DSEL}}$	PIN 2 MA+$\overline{\text{DSEL}}$	PIN 13 EC+$\overline{\text{DSEL}}$	PIN 12 EB+$\overline{\text{DSEL}}$	PIN 11 EA+$\overline{\text{DSEL}}$	PIN 16 ES+$\overline{\text{DSEL}}$	Abbreviated
DC	0	0	0	0	0	0	1	OEO
.03 HZ	0	1	1	0	1	0	0	3E-2
.1	0	0	1	0	0	1	0	1E-1
.3	0	1	1	0	0	1	0	3E-1
1	0	0	1	0	0	0	1	1EO
3	0	1	1	0	0	0	1	3E0
10	0	0	1	0	0	1	1	1E1
30	0	1	1	0	0	1	1	3E1
100	0	0	1	0	1	0	1	1E2
300	0	1	1	0	1	0	1	3E2
1000	0	0	1	0	1	1	1	1E3
3000 HZ	0	1	1	0	1	1	1	3E3

TABLE 3.9 LOWPASS OUTPUTS (Select Code 5)

1201 LOWPASS SETTING	PIN 4 MC+DSEL	PIN 3 MB+DSEL	PIN 2 MA+DSEL	PIN 13 EC+DSEL	PIN 12 EB+DSEL	PIN 11 EA+DSEL	PIN 16 DS+DSEL	Abbreviat
3 HZ	0	1	1	0	0	0	1	3EO
10	0	0	1	0	0	1	1	1E1
30	0	1	1	0	0	1	1	3E1
100	0	0	1	0	1	0	1	1E2
300	0	1	1	0	1	0	1	3E2
1000	0	0	1	0	1	1	1	1E3
3K	0	1	1	0	1	1	1	3E3
10K	0	0	1	1	0	0	1	1E4
30K	0	1	1	1	0	0	1	3E4
100K	0	0	1	1	0	1	1	1E5
300K	0	1	1	1	0	1	1	3E5
MAX	0	0	0	0	0	0	1	0E0

3.5.2.4 Device select line PIN 34

The device select line (DSEL) allows the user to multiplex several 1201's together. This is done by paralleling all other connections on the OPTION CONNECTOR, between units, and driving one DSEL line high at a time.

When the DSEL line (PIN 34), goes low, several things happen. First, the input latches are gated off, not allowing any further changes in their state. This holds the gain, overload recovery and gating commands regardless of further changes on the input pins or the gain change enable inputs (PINS 35 & 36). Note however, that the pullup resistors on the inputs are still connected. At the same time, the output selector lines are disabled.

The second effect of DSEL going low is that all outputs except $\overline{\text{OVLD}}$ (PIN 18) will go to a high impedance state. This state is characterized by a 15KΩ resistor connected to the output pullup voltage.

3.5.2.5 External pullup voltages PINS 1, 19

Two pins are provided to allow the user to select the high state voltage for the inputs and the outputs. By the use of two internal jumpers, the user can select either the 5 Volt internal pullup or the user supplied pullup voltage (at PINS 1, 19).

PIN 19 (VIN), when selected by the internal jumper, supplies the pullup voltage for all input pins, this voltage being applied to each pin through a 68KΩ resistor. The allowable range of Voltage is 0 to 15 VDC, although 5 to 15 Volts is recommended. When a voltage below approximately 2.4 VDC is used, the Schmitt triggers on the inputs will not see a logic 1 unless driven high by the external circuitry.

PIN 1 (VOUT), when selected by the internal jumper, supplies the pullup voltage for all outputs: the pullup resistor in this case is 15KΩ. The pullup voltage, again, may be any voltage between 0 and 15 VDC.

Aside from providing compatibility with various logic families, using these pins can improve the noise immunity of a system by using higher voltages for input/output data.

⚠ WARNING: Because of possible shock and fire hazards, the Input & Output jumpers should only be moved by a qualified technician.

3.5.2.6 Ground - PIN 9

One pin is supplied on the rear panel connector to supply a ground reference. In normal configurations, this pin should be used for all ground connections to external digital equipment.

3.5.2.7 Signal Timing

3. .2.7.1 Input Latches

Data Setup Time - TDS - In order for the inputs (PINS 20, 21, 22, 23, 24, 25, 30, 31, 32) to settle properly, the data on these lines must be present for at least 4.0 µSec before any of the following occur:

PIN 34 (DSEL) high to low transition
PIN 35,36 (GCE1 or GCE2) high to low transition (for appropriate data lines)
change to an invalid input gain code (for gain control lines only)

3.5.2.7.2 Gain change rate

Due to the use of relays to control gain in the 1201, the execution of a gain change is delayed by a relatively long time. This time is typically 50 mSec and is guaranteed to be less than 100 mSec. Settling time of the 1201 must be added to this number, and will depend on high pass & low pass settings. Note that the input latching rate is much faster than the gain change rat

3.5.2.7.3 Output Select Settling (delay) Time

Data on the shared output lines (PINS 2, 3, 4, 6, 11, 12, 13 & 16) will not be valid until 50µSec after the last occurance of any of the following events:

-any change of PINS 27, 28, 29 (selector inputs)
-low to high transition of PIN 34 (DSEL)
-any change of selected reading (High pass switch, low pass switch, gain switch)

3.5.3 OPERATING CONSIDERATIONS

3.5.3.1 Static Protection

The 1201 remote programming option incorporates static discharge protection which will protect it from normal use. However, if the instrument is to be used in a carpeted area or in industrial environments, the user should take extra precautions to prevent damage. Damage from static discharge of personnel can be eliminated by first touching the 1201 case before touching the connector. When operating near processes where high voltages (>1000V) are discharged suddenly, care must be taken to avoid high voltages from being coupled via stray capacitance or via common grounds.

3.5.3.2 Logic Levels & Noise Immunity

The 1201-06 is set up to work in moderately noise-free environments. For example, with the internal 5 Volt pullups and typical input thresholds, a logic 0 input of 0 Volts will have a noise margin of 2.4 Volts, and a logic 1 level of 5 Volts will have a noise margin of 3.4 Volts.

If these levels are inadequate, one quick cure is to increase the pullup voltage. This will increase the high level noise margin to approximately 13 Volts, but will do little for the low level noise margin. If speed of operation is no problem, a R-C network can be used at the inputs to reduce noise. See Figure 3.7. Otherwise, opto isolators can be used.

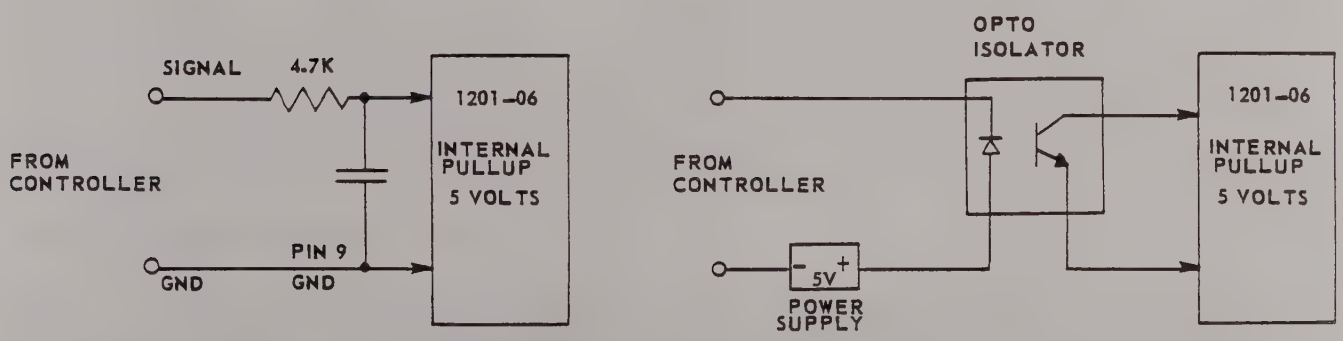


FIGURE 3.7 INPUT CIRCUITS FOR INCREASED NOISE IMMUNITY

For outputs, external pullup voltages (up to 15 Volts), differential line receivers, or opto isolators may be used to reduce sensitivity to noise. See Figure 3.8.

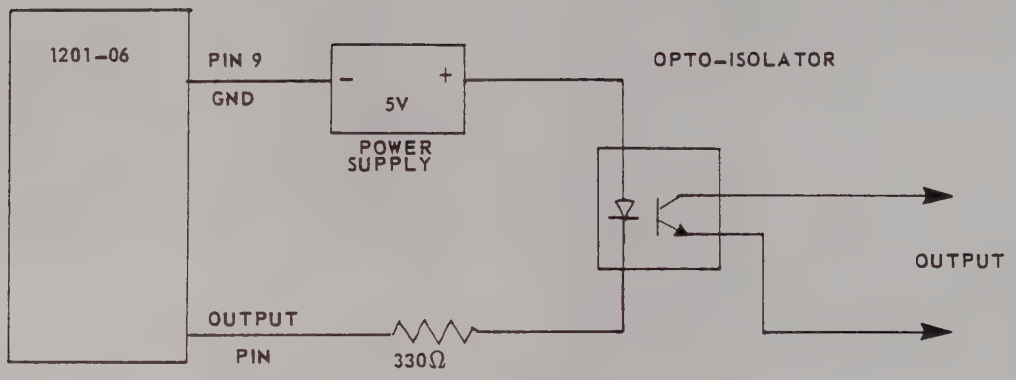


FIGURE 3.8 ISOLATED OUTPUT

SECTION 4

BATTERY OPERATION AND MAINTENANCE

4.1 GENERAL DESCRIPTION

Your ITHACO 1201 Low Noise Preamplifier is equipped with two rechargeable nickel-cadmium 1.2A-hr battery packs. When fully charged, they can be expected to operate the 1201 under normal operating conditions for time periods of well over 25 hours. However, to maintain your battery's capability for several years requires care and attention on your part.

4.2 REAR PANEL BATTERY SWITCH

The rear panel switch provides a charge rate control as well as a choice of power supply mode. In the C/10 and C/25 positions, the preamplifier operates from the internal power supply. In the battery position, the preamplifier draws power from the batteries. If the preamplifier is plugged into a live power outlet, the battery receives charging current no matter what position the rear panel switch is in. NOTE THAT THE CHARGE RATE, IN THE BATTERY POSITION, IS C/25.

4.3 DUAL RATE CHARGING SYSTEM

The dual rate charging system is designed to prolong the battery life. Either the C/10 or C/25 charge rate may be selected via the rear panel. The term C is the ampere-hour rating of the battery. Thus if C = 1.2A-hr, then C/10 implies a maximum charge current of 120mA. At C/10 the battery should full charge in 14-15 hours (charge efficiency is less than 100%). However, nickel-cadmium batteries should not be charged at the C/10 rate over long periods of time.

It is expected that a number of users will not use the battery on a routine continuous basis, but will only call upon the battery occasionally. In that case, it seemed unreasonable to maintain the battery charge rate to the C/10 limit. The C/25 position is recommended for the standby applications. The C/25 rate is high enough to charge a deep discharged battery after several days. It is high enough to amply supply the normal internal discharge current of the battery, but low enough so that it will not stress the overcharge mechanism of the battery. In addition, battery temperature rise will be reduced.

4.4 BATTERY TEMPERATURE

Another lifetime battery consideration is temperature. The 1201 is vented for cooling. The unit is designed for sufficient cooling for use, at room temperature on an open bench, at any charge rate. If the unit is installed in a closed rack where temperatures are high and air flow is restricted, it is recommended that the battery be removed for maximum life. If the battery is required, it is recommended that the charge rate be limited to C/25.

4.5 CHARGING THE BATTERY

When you receive your 1201 from the factory, the charge rate in the BATT position will be C/25. It is recommended that you use the rear panel selector switch to control the charge current. At the end of a day of using battery power, plug the 1201 into an outlet and switch to C/10 for a full overnight recharge.

4.6 CONVERTING THE CHARGE RATE TO C/10

If it is inconvenient or annoying to use the rear panel switch to control the charge rate and you would prefer the C/10 charge rate in the BATT position, you may easily convert the 1201. Simply add four wires to the rear panel selector switch. Wire pin 5 to pin 9, pin 7 to pin 11, pin 1 to pin 13 and pin 3 to pin 15 right on the switch. This will convert the charge rate in the battery position from C/25 to C/10.

4.7 PROLONGING BATTERY LIFE

The following rules for prolonging battery life should be followed:

1. Upon receipt of the instrument from the factory, charge overnight at C/10.

2. Select C/25 for standby battery charge maintenance.

3. Avoid temperature extremes and cycles as much as possible.

4. For rack mounted use, remove the battery. If battery is required, limit the charge rate to C/25 as much as possible. The consideration here is one of high temperatures.

5. If the battery (in or out of the 1201) is in storage, perform an overnight recharge at C/10 at approximately 3 month intervals.

6. Avoid repeated charge/discharge cycles of the same duration. Nickel-cadmium cells display a memory effect which means that they will eventually provide only the capacity asked from them on a routine basis. If your cells do appear to have a degraded capacity, they need replacing. Try an overnight C/10 recharge to erase any memory effect. If the batteries still appear weak, as a last resort, unplug the 1201 and leave it "on" in battery mode for several days to completely discharge the packs. Then recharge overnight at C/10. Sometimes battery capacity can be restored by cycling the pack in this manner. NOTE: Do not attempt to rush this process by discharging at high currents as cell reversal phenomenon will be aggravated leading to more permanent cell damage.

7. Recharge the battery after use even though the battery test light comes on. Nickel-cadmium batteries maintain a constant output voltage until they are almost completely discharged. The battery test light indicates that the battery has sufficient voltage to operate the 1201, not that it has ample reserves of energy.

4.8 REMOTE PROGRAMMING OPTION

Below are procedures necessary for normal servicing of the Remote Programming Option. Refer to Figure 4.C as required.

⚠ WARNING: Because of possible shock and fire hazards, these procedures should only be performed by qualified personnel. Read instructions carefully.

4.8.1 REMOVAL AND REPLACEMENT OF A101 (OPTION) CARD

⚠ WARNING: To eliminate shock hazard, remove ac power cord and disconnect any input wires before removing 1201 covers. Also, to avoid fire/burn hazard, take care not to short the batteries or any connections on the power supply card (A4).

A. Turn off the F.P. power switch, and remove top cover.

B. Remove the two front sets of hardware (on either side of the rubber button) holding the power supply (A4) in position and pivot the power supply back toward the rear panel.

C. Remove the hardware holding the battery pack in position and lay the pack along side the amplifier unit with all wiring intact. If much work is anticipated, disconnect the battery pack from the power supply card.

D. Remove two screws holding the Option connector to the rear panel and two screws holding the Option support bar to the 1201 side frames.

E. Disconnect the Ribbon cable (W3) at the motherboard (A3) and the switch connectors (P32 & P33) at the option board (A101).

F. Slide the option card out toward the front.

G. To re-install, repeat in reverse, connecting P32 to A101 PINS 1 thru 10 and P33 to A101 PINS 11 thru 20. Take care to screw the power supply down completely to avoid shorting the connections on A4.

4.8.2 CHANGING PULLUP VOLTAGE JUMPERS

⚠ WARNING: Disconnect AC power before opening top cover, and take care not to short points on the power supply card (A4).

A. Turn off the F.P. power switch, and remove top cover.

B. Remove the two front sets of hardware (on either side of the rubber button) holding the power supply (A4) in position, and pivot the power supply back toward the rear.

C. Move jumpers as required.

Input Pullup Internal - move P101 to PINS 21,22

Internal Pullup External - move P101 to PINS 22,23

External Pullup Internal - move P102 to PINS 24,25

External Pullup External - move P102 to PINS 25,26

D. Return power supply card to its original position. Take care to tighten hardware before sliding cover to prevent shorts.

E. Replace top cover and screws.

SECTION 5

PRINCIPLE OF OPERATION

5.1 GAIN CONFIGURATION

Figure 5.1 shows a block diagram of the Model 1201. Each block represents a major circuit in the unit. Also included in the block diagram is a chart showing the gain of each amplifier and internal attenuator settings vs gain switch settings.

The voltage gain of the 1201 is derived from two amplifiers, an input amplifier and an output amplifier. Each provide fixed gains of approximately 10 and 100, depending upon the gain setting at the front panel switch or the gain command given the RPO (Remote Programming Option). A switched attenuator between the two amplifiers provides attenuation steps of 0.1, 0.2, 0.5 and 1.0, giving a minimum gain of 10 (10 x 0.1 x 10 = 10) and a maximum gain of 10,000 (100 x 1.0 x 100 = 10,000). The front panel vernier gain control provides continuous control of the output amplifier gain. It allows continuous gain control over-lapping each discrete step between 10 and maximum gain to 25,000. Note that, when using the vernier, some reduction in high frequency gain (low pass switch in "MAX") may be observed.

Both amplifiers have a dual FET input stage. They both have a differential high gain stage to provide most of the open loop gain and a common mode amplifier to bias the input stage and provide good commom mode rejection. They both have a low impedance output stage to provide current for loads and gain determining feedback resistors.

Subtle differences do exist. The input stage bias control for the input amplifier is more carefully controlled.

In order to obtain good common mode rejection, the input amplifier has differential inputs and has extra components for input overload protection. The output amplifier is operated as a noninverting single input amplifier. It does have a more elaborate current limited output stage than does the input stage.

Understanding the input amplifier's gain determining feedback requires a limited understanding of the operation of the differential and common mode stages. The high gain differential stage responds to differences in the currents between the two halves of the input FET. It responds via the feedback, in such a manner as to reduce any current difference it measures. In a similar way, the common mode amplifier insists that the maximum current in either half of the input FET remain constant. Since the maximum current is held constant and the difference is also held constant, it follows that the currents in either half of the FET will remain constant.

GAIN	A_1	X1 BUFF. ATTEN.	S_2	A_2
10	10	0.1	0.1	10
20	10	0.1	0.2	10
50	10	0.1	0.5	10
100	10	0.1	1.0	10
200	100	0.01	0.2	10
500	100	0.01	0.5	10
1K	100	0.01	1.0	10
2K	100	0.01	0.2	100
5K	100	0.01	0.5	100
10K	100	0.01	1.0	100

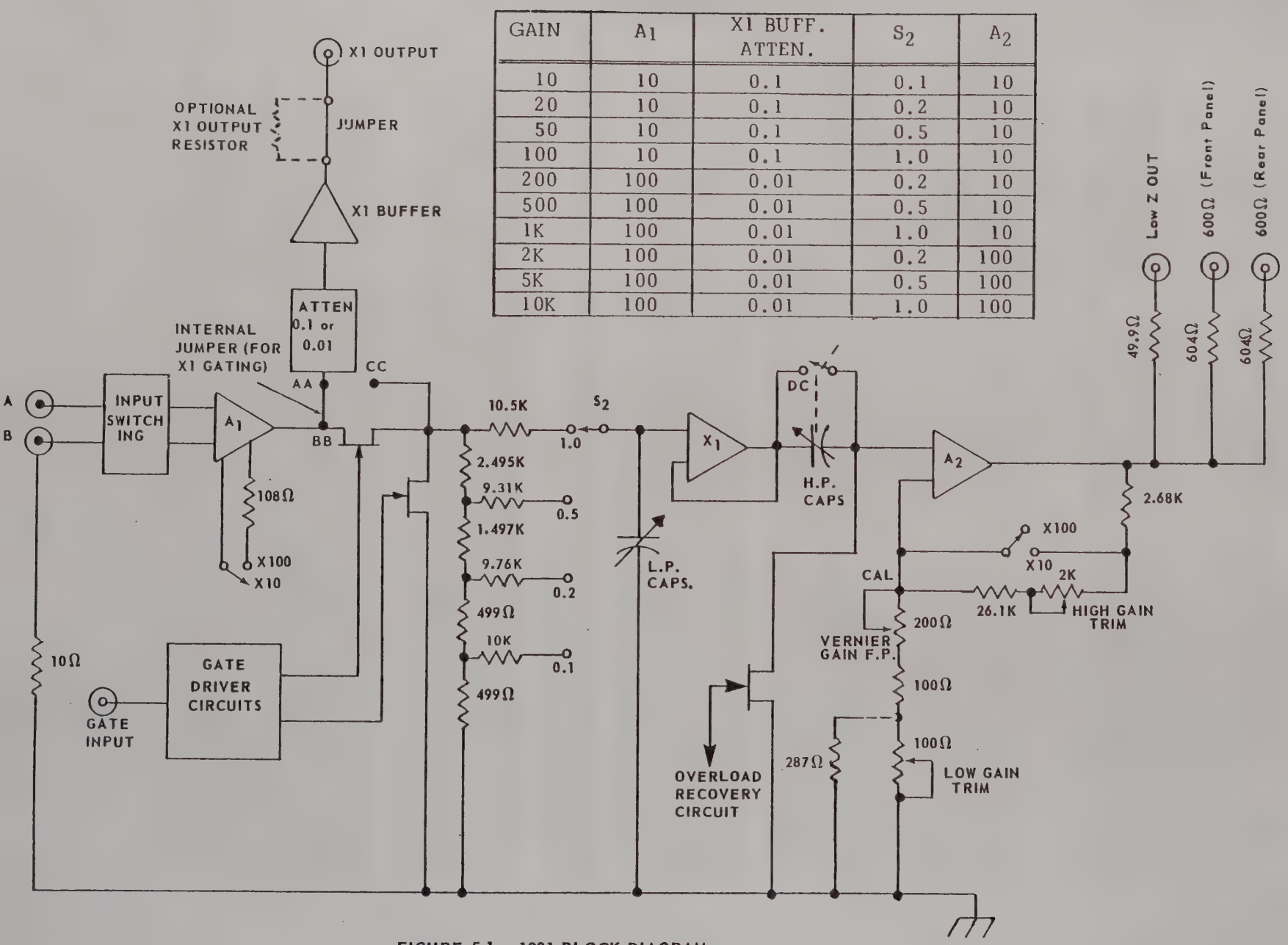


FIGURE 5.1 1201 BLOCK DIAGRAM

Consider now Figure 5.2:

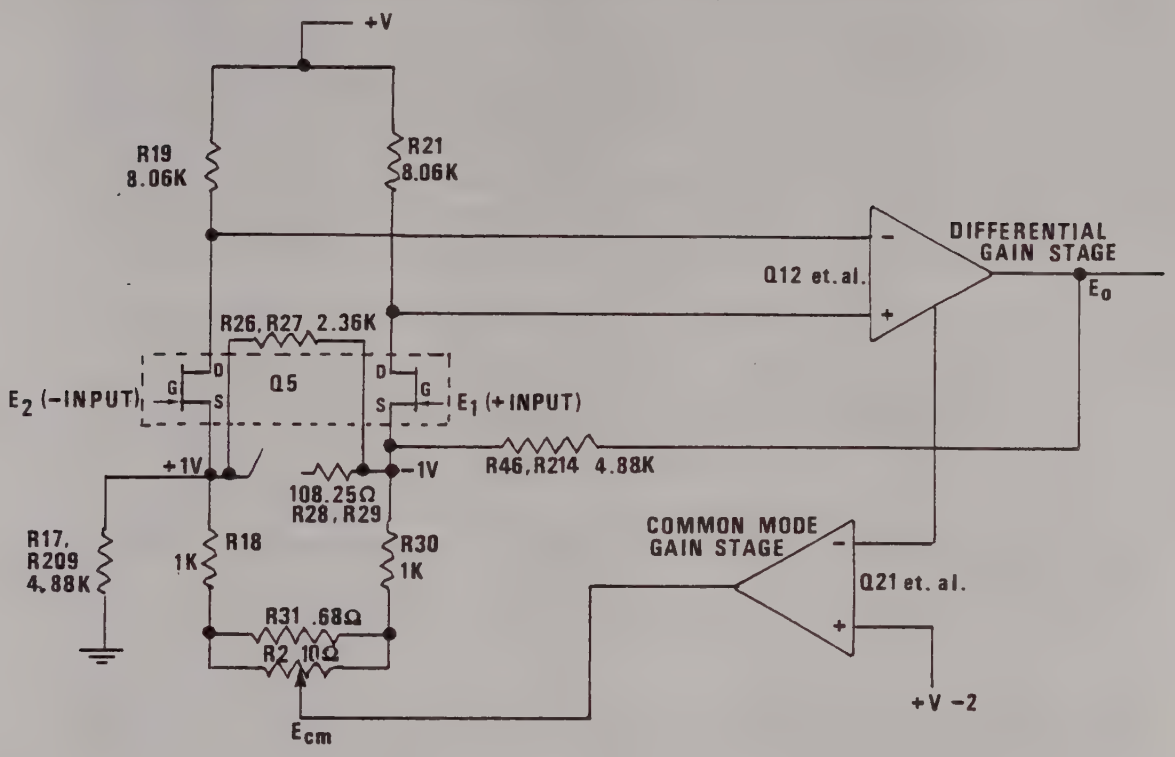


Figure 5.2

Figure 5.2 is a block diagram of the input amplifier. To the extent that it is true that the currents through the two halves of Q5 remain constant, any signal applied to the gates of Q5 must appear at its sources. Suppose we apply a differential signal $E_1 - E_2$ where E_1 is the + input voltage and E_2 is the - input voltage. As far as AC gain is concerned, let us use E_1 and E_2 to represent the source voltages at Q5. Assume low gain, i.e, R28 and R29, are disconnected. Adding currents into the left source we have:

$$\frac{-E_2}{R17 + R209} + \frac{E_{cm}-E_2}{R18 + \frac{R31,\ R2}{2}} + \frac{E_1-E_2}{R26 + R27} = \text{Current in left FET}$$

Similarly

$$\frac{E_o-E_1}{R46 + R214} + \frac{E_{cm}-E_1}{R30 + \frac{R31,\ R2}{2}} + \frac{E_2-E_1}{R26 + R27} = \text{Current in right FET}$$

But the two current, for all practical purposes, are identical. Also we note that

$$R46 + R214 = R17 + R209; \quad R18 + \frac{R31,R2}{2} = R30 + \frac{R31,R2}{2}$$

Thus, setting $I_{FET\ left} = I_{FET\ right}$ and substituting, we have:

$$\frac{E_2}{R46 + R214} + \frac{E_{cm} - E_2}{R30 + \frac{R31,R2}{2}} + \frac{E_1 - E_2}{R26 + R27} =$$

$$\frac{E_o - E_1}{R46 + R214} + \frac{E_{cm} - E_1}{R30 + \frac{R31,R2}{2}} + \frac{E_2 - E_1}{R26 + R27}$$

Note first that the E_{cm} term cancels. Grouping $E_1 - E_2$ terms and cancelling E_{cm} we have

$$\left(E_1 - E_2\right)\left(\frac{1}{R46 + R214} + \frac{1}{R30 + \frac{R31,R2}{2}} + \frac{2}{R26 + R27}\right) = \frac{E_o}{R46 + R214}$$

Thus the overall differential gain is given by

$$1 + \left(R46 + R214\right)\left(\frac{1}{R30 + \frac{R31,\ R2}{2}} + \frac{2}{R26 + R27}\right)$$

Plugging in the values, we find a gain of 1+ 9.014 = 10.014 in low gain. A similar analysis will lead to a result of 100.177 for high gain.

Operation of the dual FET input stages of the two amplifiers is very similar. A common mode amplifier sets up a bias current through the dual FET. Another FET running in cascode, Q4 in the input amplifier and Q57 in the output amplifier, sets up a fixed common mode bias ($\approx$3.5 volts on the input FET). By fixing the bias and riding it upon common mode signals, the input FET's common mode rejection is maximized. It never "sees" common mode signals. The load resistors for the FETs in either amplifier are 8.05K resistors.

The main differential gain stages in the two amplifiers are identical. Consider the input amplifier. Signals from the input stage are coupled to the differential gain stage via an emitter follower Q7. Transistors Q9 and Q10 form a current source supplying a constant current slightly under 4 mA. That current is split approximately evenly between the two halves of Q12. Any common mode signal from the input stage appears at TP3 and feeds the common mode stage which responds in such a manner as to reduce the signals.

Since Q9 and Q10 are a current source, any common mode signal has very little effect on the currents through Q12. Differential signals, on the other hand, do upset the balance of currents in Q12. Suppose the left side current (Figure 9.2) increases and the right side current decreases. The voltage across R53 will increase due to increased current flow. Q14 applies the voltage increase to the base of Q90 causing an increase in its current. Since Q90 looks into the collector load presented by Q13 and visa versa, a very large voltage swing is produced by a minute current change. Thus the differential gain stage achieves high gain.

A number of peripheral components are in evidence. Transistors Q13 and Q113 perform two functions. They isolate the bases of Q12 from the large voltage swings at the output. Thus a "Miller effect" pole is removed which would severely limit bandwidth. Q8 forms a current source which, via R43 and Q11 biases the cascode transistors Q13 and Q113 for proper operation. The collector of Q11 is patched to the current source for two reasons. The current is available, thus saving battery power since a bias needs to be applied to the current source. In addition, the high impedance collector load of Q11 increases the current source output impedance, thus making it a more ideal current source. Transistor Q88 and diode CR48 are important under overload conditions. They control saturation and prevent oscillations.

The output stages of the two amplifiers are similar in concept and design. An emitter follower, biased by a current source, couples the differential gain stage output to the bipolar output transistors. Both outputs will tolerate a short circuit to ground indefinitely. The input amplifier does not normally supply more than a few milliamps to a load, consequently protection is quite simple. The output amplifier must supply about 35mA, to loads and must also tolerate capacitive loads. Thus the output is current limited in an active manner as opposed to the simpler protection employed in the input amplifier.

Diodes CR4 and CR5 provide input overvoltage protection for negative going input voltages. They are normally reverse biased, but under severe overloads will conduct and turn on CR2 and CR3. A large enough negative input voltage will burn open R4 and R5, thus removing the input voltage.

A large positive input voltage turns on CR44 and CR45. R16 and R36 prevent excessive currents in Q5. Diode CR6 will turn off the bias generator and thus allow TP1 and TP4 to rise up in voltage and follow the input, thus limiting the input currents. R17 bears the most stress under positive overload. In either case, damage should be limited to easily replaced, inexpensive components, not the expensive FET Q5.

Gain control of the output amplifier is derived from a feedback arrangement identical to that for a noninverting op amp. Resistors connect the amplifier output to the inverting input. More resistors connect the inverting input to ground. The total gain of the second stage is then given by:

$$\frac{\text{total feedback resistance}}{\text{total resistance to ground (from summing junction)}} + 1$$

The common mode gain stages of the two amplifiers are similar. They are simplified versions of the differential gain stages, but operate on the same basic principle.

The common mode bias is compared with the V-2 bias voltage. Any change in the common mode bias causes an unbalance in the current flow in the two halves of the dual transistor in the common mode amplifier. This unbalance causes a large output voltage swing in exactly the same manner as in the differential gain stage. Output buffers in the common mode amplifiers then feed the voltage swing back into the input stage of the amplifier in such a manner as to return the common mode bias to the correct value.

The output amplifier's common mode stage has a rather strange looking emitter follower driving a current source. The strange arrangement was dictated by a latchup mode which can occur if the current source transistor is allowed to saturate.

Diodes CR10 and CR11 are part of the input overload protection scheme employed in the input amplifier. Diodes CR49 and CR 50 reduce the possibility for saturation of Q10 when common mode input signals are applied.

5.2 GATING CIRCUIT

The gating circuit is designed to allow muting of the amplifier in the event that a large input signal is anticipated. It switches the input to the attenuator and filters to ground whenever the center of the gate control input BNC is grounded.

In normal operation, Q34 is biased "on" and Q35 is held off. When the gate is closed, Q35 is switched on and Q34 off in order to isolate the input amplifier from the rest of the 1201.

Operation of the gate control circuit is quite straightforward. Transistors Q87 and Q33 are a differential pair. As long as the control input voltage is above the trip point ($\approx$ 1.4 volts), Q87 conducts and holds Q30 "on". Q30 forces current to flow through the collector base junction of Q91, thus saturating Q91 in reverse and providing a low impedance bias connection for Q34.

When the control input is pulled low, Q87 shuts off and Q33 turns on. Q33 turns Q31 on and thus saturates Q93 in reverse. Q93 then provides a low resistance, low offset bias path for Q35.

5.3 X1 OUTPUT

The X1 output amplifier provides the user a means of viewing the differential input signal at unity gain. The signal from the input amplifier is connected via jumper AA to BB to a 0.1 or 0.01 switched attenuator.

NOTE: As shipped from the factory, the X1 amplifier is connected upstream of the gate. If the user wishes to gate the X1 input signal, simply remove the AA to BB jumper. Reinstall the jumper between pins AA and CC.

The output of the attenuator, after a bit of frequency shaping, is fed to one base of Q71. Q71 operates as a simple differential amplifier. Voltages developed across load resistor R156 are level shifted and attenuated via Q70, R155 and R151 and fed to the output transistors Q52 and Q55. Output signals are then fed back to Q71 via R152 in such a manner as to re-balance the currents in the two halves of Q71. Transistors Q53 and Q54 provide current limits. R133 and C44 isolate capacitive loads and prevent unwanted oscillations.

5.4 FILTERS AND BUFFER

The low and high pass filters are simple RC sections isolated from each other by the buffer amplifier. The front panel switches select the proper RC time constants for the desired frequency cutoffs. Both sections are precharged to reduce settling times.

The buffer amplifier is similar to the X1 output amplifier. Signals from a differential pair are level shifted and fed to a bipolar output. In this case, though, the amplifier is more accurate. A dual FET, Q103, is used as a differential pair in order to provide a high impedance load for the low pass section. An active current mirror, Q102, provides high open loop gain. Current source Q104 provides bias for the input pair Q103. Current source Q107 biases the emitter follower Q105 to maintain open loop gain and reduce distortion.

SECTION 6

TROUBLESHOOTING THE 1201

6.1 GENERAL

The procedure described in this section will help the user to localize the most common malfunctions of the 1201. Helpful information may be found in the sections on principles of operation, operating instructions, and battery operation and maintenance. The procedures and waveforms given apply to particular settings of the frequency range and gain controls, but may be used with other frequencies by proper scaling. Contact the factory before troubleshooting units under warranty.

6.2 INSTRUMENTS REQUIRED

Digital DC voltmeter
AC voltmeter
10 dB step attenuator
Oscilloscope with 10:1 probe
Ohmmeter
Frequency counter

6.3 HOW TO PROCEED

If possible, first test the 1201 with nominal line voltage, and with input and controls (Section 6.4) as described in the standard conditions. Check the output on a voltmeter or oscilloscope. If this test indicates a fault in the 1201, proceed to localize the malfunctioning circuit.

If the fault appears only in battery operation, proceed with power supply troubleshooting.

Location of connectors test points and components are given in the following figures:

Figure 3.1	External Switches and Connectors
Figure 6.6	Block Diagram with Test Points
Figure 9.1	Major Assembly Components and Test Points
Figure 9.8	Motherboard Components
Figure 9.9	Power Supply Board Components
Figure 9.10	Battery Pack

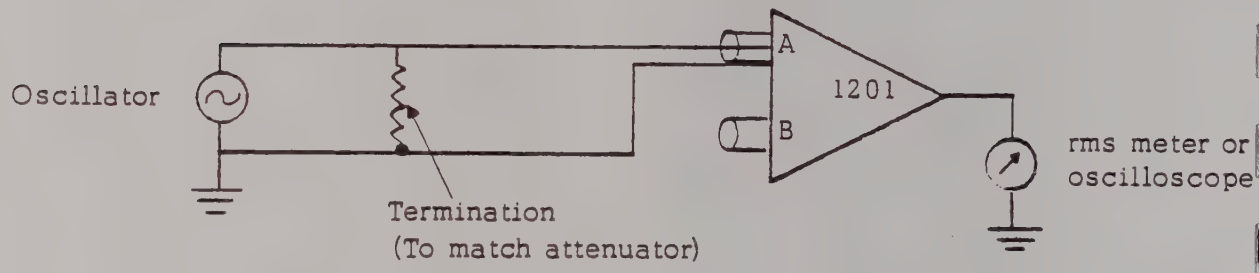
Check the power supply voltages (line operation) before proceeding with faultfinding. Plus supply voltage must be +16.4V to +16.6V. Minus supply voltage must be -16.1V to -16.9V.

Various steps in this troubleshooting procedure require removal of the top cover and battery pack. Be careful to disconnect the battery by pulling the plugs when necessary to remove voltage from exposed components.

6.4 STANDARD CONDITIONS

The test procedure and description given in this section apply to the following standard test setup unless otherwise noted:

Rear Panel Power Setting	Consult Section 2.3 for proper power setting
Batt, C/10, C/25 (rear panel)	C/25
Gain	X10, CAL
Low Pass	Max
High Pass	DC
Input A (AC-GND-DC)	DC
Input B (AC-GND-DC)	GND
On/Off	Off



After verifying that the power source is correct, turn the unit "On". Set the oscillator to 1 kHz, 0.1 volt rms. The 1201 should be providing a clean, 1 kHz, 1 volt rms signal at the 600 ohm and low -Z output and a 0.1 volt rms signal at the X1 output.

6.5 CHECKING THE POWER SUPPLY

6.5.1 POSITIVE AND NEGATIVE SUPPLIES

Turn the On/Off switch to "Off" and remove the line cord from the rear panel. Remove the 1201 top cover. Unscrew the four screws holding the battery pack in place and set the battery pack next to the amplifier. Access to P4 (a small three receptacle plug) near the right frame is now possible (see location in Figure 9.1). With the Batt, C/10, C/25 switch (rear panel) in C/25 the voltage at 58 (violet wire) must be -16.1 to -16.9V (measured to chassis ground), and the voltage at 60 (red wire) must be +16.4 to +16.5V (measured to chassis ground), when the line cord is reconnected and the power is on. If these voltages are correct, proceed to check the other circuits. If the above supply voltages are not correct, remove P4 from the motherboard and measure the P4 pins again using the center (black and white) wire as reference.

CAUTION: Battery power is present for the power supply board

unless the batteries are unplugged (P10 and P11). See Figure 9.1.

Incorrect voltage on P4 indicates trouble on the A4 power supply board. Correct voltage does not guarantee that the supply is regulating properly. Connect a resistive load to each supply, one at a time, of approximately 275 ohms to ground. The voltage measured at Pin 21 of the A4 card to ground (pin 34) must not change more than 20 millivolts when it is loaded. Similarly, the voltage measured at pin 5 to pin 34 (-16.5V nominal) must not change more than 20 millivolts when it is loaded. (Resistive load may be connected either on P4 or on the power supply board terminals).

Defective regulation or wrong voltage at P4 requires troubleshooting the power supply. The input voltages must be approximately -32V to -35V across C1 and +32V to +35V across C2. Ripple on C1 and C2 must be no greater than 1.5V p-p with a 120 ohm load on each supply. U1 acts with a series transistor to regulate the positive supply. Changing current to the + battery goes through the Q2 -CR6 circuit with another series transistor. Reference voltage for the minus circuit goes to U2 and Q6. Transistor Q4 provides short circuit current limiting for the minus supply while U1 current limits the positive supply. Both current limiters are of the "foldback" type, that is, current drain from either supply can reach a threshold value after which the current actually decreases, thus providing short circuit protection. Charging current to the battery goes through the Q7 - CR11 circuit with another series pass transistor.

No visible ripple should be present on either supply output.

6.5.2 BATTERIES

See Battery Operation and Maintenance, Section 4.

If possible, using line input voltage, determine whether the 1201 is operating normally with the rear panel Batt, C/10, C/25 switch in C/25 position. Operate the Batt test switch and see if the Batt test light comes on. No light on either side indicates a battery with less than 11.1V charge.

Special note is made here of the Sections on the charging systems in Section 4.3, the rear panel battery switch in Section 4.2 and the charging and battery life sections, 4.5 and 4.7.

Assuming that all attempts to charge the battery have failed, a check of the battery cnarging circuit can be made. First disconnect power from the 1201 and switch the power on/off switch to "off". Remove the 1201 top cover and remove the four screws holding the battery pack in place and the two front screws holding the power supply board. Pivot the power supply up as shown in Figure 9.1 and remove P10 and P 11, the plugs attached to wires from the

battery pack. Remove the battery pack from the 1201 chassis. Connect an ammeter as shown in Table 6.5, reconnect the line voltage and measure the changing currents (Note: these currents will be present whether the power switch in on or off.)

Rear Panel Slide Switch	Ammeter	Current Min	Typ	Max
C/25	connect between pins 1 & 2 on A4 (power supply card)	40ma	47ma	54ma
C/10		100ma	117ma	134ma
C/10	connect between pins 19 & 20 on A4 (power supply card)	102ma	120ma	138ma
C/25		47ma	56ma	65ma

TABLE 6.5

If all currents are correct and the batteries still cannot be charged, a defective cell is indicated. Cells may be tested by removing the cell packs from the case and measuring the voltage drop across each. Normal voltage is on the order of 1.28V. Shorted cells read near 0V.

6.6 CHECKING THE FUNCTIONAL BLOCKS

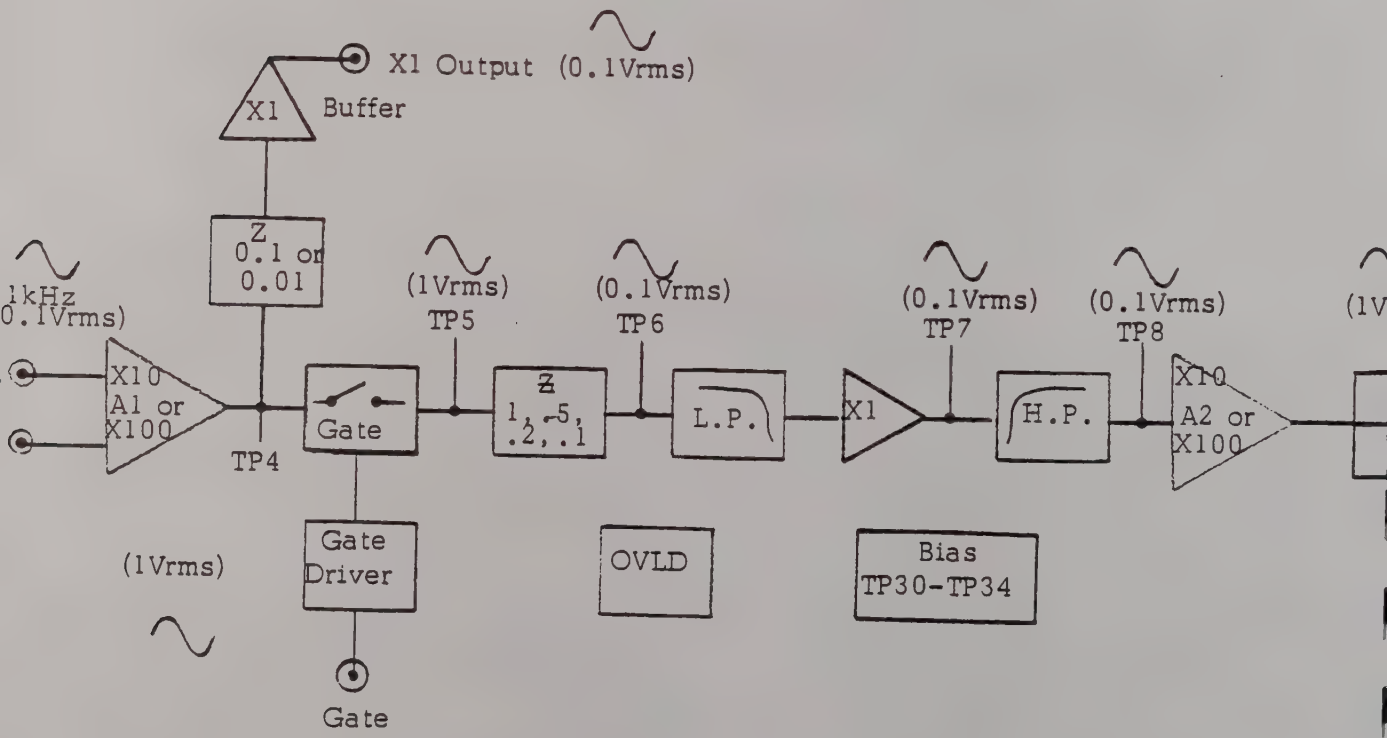


FIGURE 6.6 BLOCK DIAGRAM OF 1201 SHOWING TEST POINTS

Voltages (with respect to Supply		Circuits Affected			
	Test Point	First Stage	Miscellaneous		Output Stage
-V+3	TP30	Q2			
-V+6.8	TP31	Q8	BUFFER Q104, Q107	OVLD DET Q39, Q42	Q64
V-.6	TP32	Q21			
V-2	TP34	Q15 & Q3	GATE Q84		Q56, Q111 Q63
V-6.8	TP33	Q6			

TABLE 6.6

6.6.1 CHECKING THE BIAS CIRCUITS

Set all controls to standard conditions.
With a dc voltmeter measure the supply voltage as given in 6.5.1. If these are correct, measure the bias voltage on TP30 - TP34. Voltage with respect to plus and minus supplies are approximately as given in Table 6.6. With respect to ground the voltages are approximately as follows:

Test Point	Voltage
TP30	-14.0V
TP31	- 9.7V
TP32	+15.8V
TP33	+ 9.7V
TP34	+14.4V

TABLE 6.7

Incorrect bias voltages indicate a failure in one or more lines or circuits. Use Table 6.6 to locate fault.

6.6.2 LOCALIZATION TO A FUNCTIONAL BLOCK

With the 1201 controls and inputs set to standard conditions, and with correct supply voltage (±16.5V) and bias voltage, proceed to measure voltage at outputs of the various stages. If the input oscillator is removed and the Input A (AC-GND-DC) is switched to GND (both inputs now grounded) all four outputs must be nearly 0 V. Return the Input A (AC-GND-DC) switch to DC and reconnect the oscillator. Outputs at rear and front panels and at test points are shown in Figure 6.6 and Table 6.8. Measurements can be made with an oscilloscope or suitable voltmeter.

Test Point	(Input = 1 kHz 0.1V rms)
TP4	1V rms
X1 Output	0.1V rms
TP5	1V rms
TP6	0.1V rms
TP7	0.1V rms
TP8	0.1V rms
600 ohm output	1V rms
50 ohm output	1V rms

TABLE 6.8

Using the table in Figure 5.1 (1201 block diagram) voltage can be increased or decreased at each test point by switching the gain switch, thus enabling troubleshooting of the gain switching and attenuation circuits.

6.7 LOCALIZATION WITHIN FUNCTIONAL BLOCK

6.7.1 BIAS CIRCUITS

See Section 6.6.1.

6.7.2 OVERLOAD CIRCUITS

Input overload - connect a shorting cap on the gate input. Switch the Input A (AC-GND-DC) to DC and connect a variable DC voltage to the A input. With a dc voltmeter monitor TP4. Increase the voltage until the overload light comes on.

Min	Typ	Max
±10.3V	±11.7V	±12.0V

TABLE 6.9

Common mode overload - Connect a shorting cap on the gate input. Switch the Input A (AC-GND-DC) to DC and the Input B (AC-GND-DC) to DC. Connect a variable DC voltage to both inputs. Monitor the input DC voltage with a voltmeter. Increase the voltage until the overload light comes on.

Min	Typ	Max
+8.2V	+9.4V	+10.6V
-8.7V	-10V	-12.4V

TABLE 6.10

Output overload - Set the controls as in standard conditions (Section 6.4), except set GAIN at X1K.

Check to be certain that the shorting cap has been removed from the gate input. Connect a variable DC voltage to the A input, monitor either 600 ohm output with a dc voltmeter. Increase the voltage until the overload light comes on.

Min	Typ	Max
±10.3V	±11.7V	±12.0V

TABLE 6.11

6.7.3 OUTPUT AMPLIFIER

Refer to Section 5.1 for Theory of Operation.

This amplifier may be dc isolated from the previous stages by switching the high pass switch to any position except DC. Voltage for the common mode amplifier at TP10 equals the +V-2 voltage and is approximately +14.3Vdc. This amplifier has two gains, X10 and X100, controlled by relay K6. K4 and K6 are latching relays which will remain in either switching position without drawing coil current. Energizing signal for these relays is a pulse from Q75-Q76 and Q77-Q78 combinations which ceases as soon as the R177, R178, U1 circuit senses that the switching is accomplished and shuts off the pulse. Relays automatically switch to the correct position when they are connected in the circuit.

Current limiting is provided in the low Z output driver and may be tested by connecting the output through an ammeter to ground and driving the output stage to maximum positive and then maximum negative. Current limit is approximately 40ma in either direction.

6.7.4 HIGH PASS

Set up the amplifier according to the standard conditions given in Section 6.4. At each position of the high pass switch the output must be -3dB down at that frequency. Vary the input frequency while monitoring the amplifier output.

6.7.5 BUFFER

Gain of the buffer is X1. TP 7 provides a monitor of the buffer output. TP6 is the nearest monitor for the buffer input.

6.7.6 LOW PASS

Set up the amplifier according to the standard conditions given in Section 6.4. At each position of the low pass switch the output must be -3 dB down at that frequency. -3 dB frequency for the max position is approximately 500 kHz or more for the X10 gain and 420 kHz for X2K gain.

6.7.7 ATTENUATOR

Set the amplifier according to the standard conditions in Section 6.4. Monitor the voltage at TP6 and switch the gain switch using the 10, 20, 50 and 100 positions. At each step the attenuation is as shown in Figure 5.1 for S2, either 0.1, 0.2, 0.5 or 1.0. Q97-Q99 are MOS field effect transistors and require special precautions when handling. See recommended handling procedures for MOS devices in Section 9. Q43-Q46 are controlled by gain switch S2-A or, in the remote position by the remote programming option.

The attenuator may be bypassed by connecting TP5 and TP6 with a jumper.

6.7.8 GATE AND GATE DRIVER

See Section 5.2 for an explanation of circuit operation.

Set all controls and input voltage as given in Section 6.4, Standard Conditions. While observing the output waveform, alternately open and shut the gate input to ground. The output waveform must alternately read 0V and 1Vrms. If not, connect a gating waveform to the gate input and observe the gate signals at TP20 and TP21. A low frequency (such as 50 Hz) results in square wave input, a square wave of approximately 32V p-p at TP20 and TP21. TP20 and TP21 waveforms are 180° out of phase with each other.

The gate may be temporarily bypassed by connecting TP4 and TP5 or TP4 and TP6 with a jumper. Connecting TP4 and TP6 also bypasses the attenuator (X1 attenuator).

6.7.9 INPUT AMPLIFIER

The input amplifier is similar to the output amplifier in configuration and gain steps (X10, X100). See Section 5.1.

With both A & B inputs grounded, the T P4 voltage must be near zero volts in any gain position or must be adjustable to zero using the front panel zero pot R1.

Gain is controlled by relay K2 which is not a latching relay as K4 and K6 are in the output amplifier. K2 is open in the X10 position. Voltage at TP3 must nearly equal the voltage at TP 34, approximately +14.4V. TP1 is provided to observe the common mode feedback voltage.

The input protection network as described in Section 5.1 is subject to stress from over voltage at the input terminals and may need to be checked if this type of damage has occurred. This includes diodes CR2-CR5 with CR44 and CR45.

6.8 CHECKING THE REMOTE PROGRAMMING OPTION 06

If possible, isolate a trouble to the option by verifying that the 1201 operates normally in local operation using front panel controls. It is recommended that the factory be consulted before attempting to repair the Option 06, especially if the two programmable chips are suspected. These also require special handling as given in Section 9.

6.9 REMOVING AND REPLACING COMPONENTS

Components on the power supply board are accessible by removing the two screws holding the front of the power supply board (disconnect power first) and rotating the board upward.

CAUTION: Battery power is present on the power supply board unless the batteries are unplugged from it (P10 and P11) See Figure 9.1.

Motherboard components are accessible by removing the battery pack. Components located near the input circuits are accessible only when the shield cover is removed. Two screws hold it in place. To remove the shield, first disconnect input line power and remove the battery pack. Be sure the power On/Off switch is off and the rear panel slide switch is in a line position or the battery pack is completely unplugged from the power supply board. The shield may be lifted slightly and moved to the rear after P1 and P2 are removed from the motherboard. (Note their orientation - wire color is marked on the motherboard.)

When removing components from a board, be careful not to heat wire runs on the board excessively so that they peel off. Use solder wick or a vacuum type solder remover to allow multi pin components to be removed. Some solder may remain in the hole, requiring the component to be gently lifted while heating the lead or pad.

Some components require special handling precautions when removing and and replacing. These are MOS field effect devices subject to damage by static discharge. In the 1201 these are Q97- 99 and U1-U3 on the motherboard. U1 and U2 on the 1201-06 Remote Programming Option also contains MOS field effect devices. See Section 9, Recommended Handling Procedures for MOS Devices.

SECTION 7

CALIBRATION PROCEDURE

7.1 GENERAL

It is assumed that the instrument is working and meets specifications listed for its performance.

7.2 INSTRUMENTS REQUIRED

Digital DC voltmeter
AC voltmeter
10 dB step attenuator
Oscillator with 10:1 probe
Ohmmeter
Frequency counter

7.3 PROCEDURE

Follow procedures as outlined on the following pages.

1201 TEST DATA SHEET

S.N.	CMR @ 20Hz	CMR @ 10KHz	CMR @ 100KHz	A & B Input Current	Noise 3KHz-Max	Noise 300Hz-3KHz	Current Noise (215K to Gnd)
				A B			
				A B			
				A B			
				A B			
				A B			
				A B			
				A B			
				A B			
				A B			
				A B			
				A B			
				A B			
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				A B			
				A B			
				A B			
				A B			

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
Unregulated D.C.	Power ON	N/A	Measure D.C. out on C_1 and C_2	32V		35V	
Regulated power supply check	N/A	N/A	Connect DVM between pin 21 on A4 card and ground. (use ground on A4 card) adjust R5 for proper voltage	+16.4V	+16.5V	+16.6 V	
	N/A	N/A	DVM between pin 5 on A4 card and ground	-16.1 V		-16.9 V	
	Disconnect P8 from A4 card	N/A	Connect ammeter between pins 4 & 5 of P8	35MA.	130MA	210MA	Reconnect P8 after test (-)
	Disconnect P9 from A4 card	N/A	Connect ammeter between pin 4 of P8 and pin 21	150MA	196MA	230MA	Reconnect P9 after test (+)

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
Charger output check	Rear panel slide switch to C25		Connect ammeter between pins 1 and 2 on A4 card	40MA	47MA	54MA	
	Set switch to C10			100MA	117MA	134MA	
	Switch still set to C10		Connect ammeter between pin 18 and 20 on A4 card	102MA	120MA	138MA	
	Rear panel slide switch to C25			47MA	56MA	65MA	
Unregulated ripple	Rear panel to C10		Remove power connector to main board. Load both +16.5V bus and -16.5V bus with 120Ω resistors. Short pins 1 to 2 and 18 to 20 on regular board. Measure ripple on C_1 and C_2.			1.2V P-P	Disconnect resistors and short circuits. Connect power connecto back to main board.
Input switching	Set both input switches to ground. (Power removed)		Measure resistance from each input to ground	10mΩ			
			Measure resistance from shells of input BNC's to ground	9.5 Ω		10.7Ω	
Bias	Front panel input switches to gnd (power on)		One voltmeter lead to R26,R27 junction. Other voltmeter lead	3.4V	3.5V	3.6V	Adjust R23 for 3.5V

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
Output amplifier offset check	R/P C25 HP 1Hz LP 3Hz Gain X2K A Gnd B Gnd Gate Open	N/A	Adjust if necessary, R144 for 0V±1mV at low Z output (J11)	-1mV	0V	+1mV	
Low pass buffer offset check	Same as above except: HP D.C. Gate GROUND	N/A	Adjust R239 if necessary, for 0V±1mV at low Z output J11	-1mV	0V	+1mV	
Input offset	Same as above except gate open	N/A	Adjust front panel zero to midrange. Then adjust R24 (course zero) for 0V at low Z output. Fine tweak with front panel zero adjust				Output could drift ±5mV

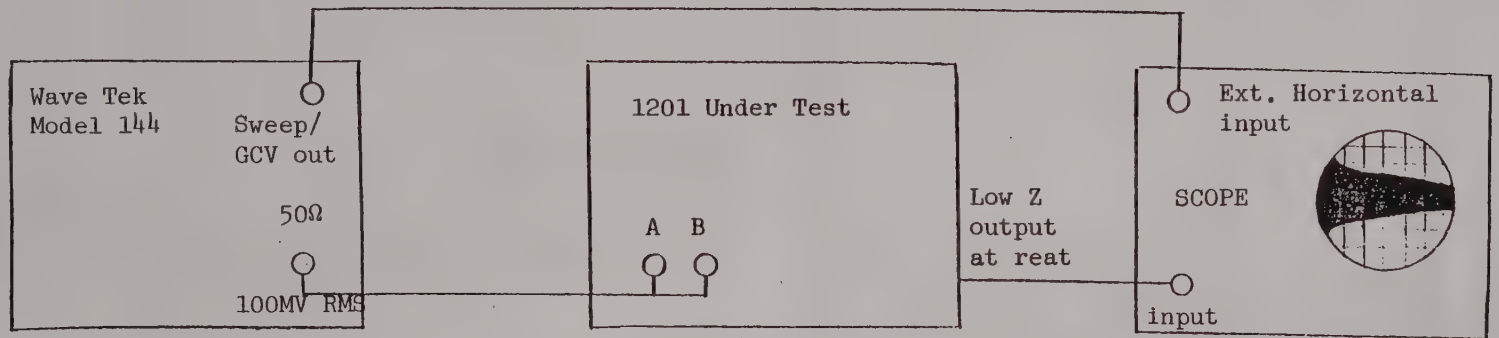
TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
Gain x200 check	RP switch_____C/25 HP_____.03Hz LP_____MAX Gain_____x200 A_____DC B_____Gnd Gate_____open Verify front panel variable gain switch is in the calibrate position	10.0mV rms @ 1KHz to A	Adjust if necessary R180 for 2.0V rms at low Z output	1.987V	2.00V	2.013 V	
Gain X2K check	Same as above except 2K Gain	1.0mV rms @ 1K42 to A	Adjust if necessary R182 (High gain trim) for 2.0V at low Z output	1.987V	2.00V	2.013 V	
Variable gain check	Same as above	Same as above 1.0mV rms	Rotate variable gain control to maximum. (Still monitoring low Z output)	5.03V		6.04V	After test is computed return variable gain control back to calibrate position

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
nput A current heck	RP Switch C/25 LP 3Hz HP DC Gain X1K A AC (shielded) B Gnd Gate open	N/A	monitor low Z output			±0.8 V (±8PA)	Record Voltage
nput B urrent check	RP Switch C/25 LP 3Hz HP DC Gain X1K A Gnd B AC (shielded) Gate open	N/A	Monitor low Z output			±0.8V (±8PA)	Record Voltage
nput difference urrent			Calculate the difference in readings obtained in the above two steps			500 mV	Record input current checks on 1201 test data sheet

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
Frequency response at 420 KHz	RP_____C25 HP_____DC LP_____MAX Gain_____X2K Gate_____Open A_____DC B_____Gnd	1mV rms at 420KHz to A	Monitor low Z output and adjust R65 for 1.42V rms				
Frequency response at 300KHz	Same as above except: LP_____300k	1mV at 300KHz to A	Monitor low Z output and adjust C77 for 1.42V rms				
CMR at 20Hz	RP_____C25 HP_____DC LP_____MAX Gain_____X10K A_____DC B_____DC Gate_____Open Mechanically center CMR pot (R1)	1vrms at 20Hz to both inputs	Install a 3pF Capacitor (mica or mylar) from the A input source of Q5 to ground. Monitor low Z output. First adjust R209 for minimum output using lock in amplifier	135 dB	140dB		May be necessary to add SBT capacitor to either source of Q5. Record CMR for 20Hz, 10KHz, and 100KHz on 1201 Test Data Sheet

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS	COMMENTS

HF CMR: Make the following test setup for HF CMR Adjustment



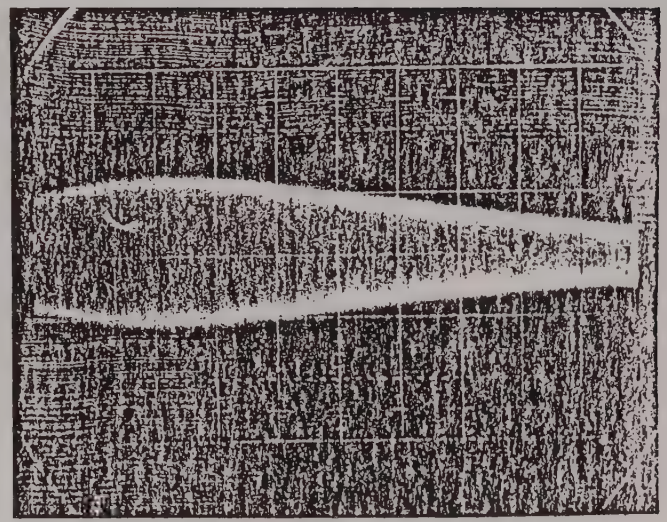
Dial setting:
Freq: X100K
Freq. dial: 2.6
Mode: Continuous sweep
Sweep time: 10ms

1201 Settings:
HP: DC
LP: MAX
Gain: X10K
A input: DC
B input: DC

Vertical Sens: 0.5V/CM

Monitor scope and adjust C4 and C82 for the smallest possible common mode signal.

Should approximate shape of drawing as shown

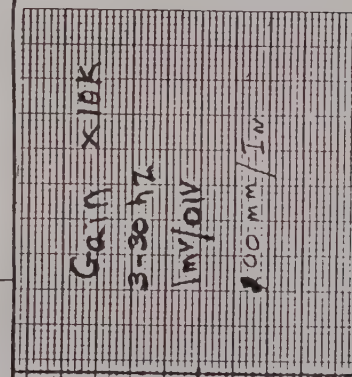
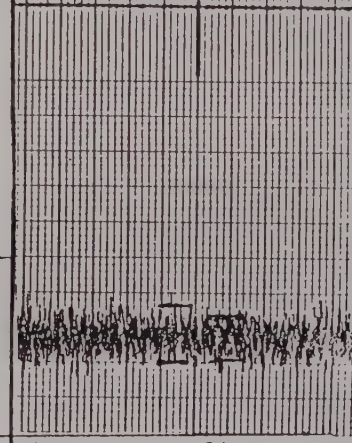


TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
CMR CHECK	RP_____C25 HP_____DC LP_____MAX A_____DC B_____DC Gate_____Open						
	Gain = 100	1.00Vrms @ 20Hz @ 100Hz @ 1kHz @ 10kHz @ 100kHz @ 500kHz	Adjust Front Panel for Best CMR	115dB 115dB 95dB 75dB 55dB 40dB			Record Results
	Gain = 10k	1.00Vrms @ 20Hz @ 100Hz @ 1kHz @ 10kHz 100mVrms @ 100kHz @ 500kHz	Adjust Front Panel for Best CMR	125dB 125dB 105dB 85dB 65dB 50dB			

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
Overload	RP C25 HP DC LP MAX Gain X2K A DC B Gnd Gate Open	DC voltage source to "A".	Monitor low Z output and check at what levels overload light comes on for both + and - inputs	+10.5 -10.5	+11.4 -11.4	+12 -12	
Recovery Switch	RP C25 HP 3HZ LP 300K Gain X2K A DC B DC Gate Open		With digital ohmmeter check each input to ground when the overload recovery switch is operated	9.5K	10K	10.5K	

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
Recovery Switch (add input shield at conclusion of this test)	RP C25 HP 3Hz LP 300K Gain X2K A DC B DC Gate Open		Connect digital ohmmeter between TP8 and chassis ground. Verify that the resistance goes from 1mΩ to 1KΩ when the overload recovery switch is operated.				
Stability check I	RP C25 HP DC LP MAX Gain X200 A Gnd B Gnd Gate Open		Connect a .0022 µf cap. from low Z output to ground. At the same time monitor low Z output with scope. Verify there are no oscillations				Use wide band scope.

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
Stability Check II	RP C25 HP DC LP MAX Gain X10K A DC B Gnd Gate Open	Connect a 215KΩ resistor from A input to ground	Connect a .0022 µf capacitor from low Z output to gnd. At same time monitor low Z output with scope. Verify there are no oscillations				Use wide band scope.
Stability check III	RP C25 HP DC LP MAX Gain x200 A Gnd B Gnd Gate Open	N/A	Connect a 220Pf capacitor from low Z output to gnd. At same time monitor low Z output with scope. Verify there are no oscillations				Use wide band scope.

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
Gate function	RP C25 HP DC LP 300K A Gnd B DC Gain X10	5KHz 5V P-P square wave to gate input 20KHz 100mV rms to B input.	Monitor low Z output to insure gating function is working				
Noise	RP C25 HP 3KHz LP MAX Gain X10K A Gnd B Gnd Gate Open	N/A	Monitor low Z output with Ballintine rms meter (Record results on 1201 Test Data Sheet)			42.0 mv rms	
	Same as above except: HP 300Hz LP 3KHz	N/A	Same as above (Record results)			5.0 mv	
	Same as above except HP 3Hz LP 30Hz	N/A	Record for five minutes low Z otuput on strip chart recorder.				Compare results with sample given.

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
Noise Cont.	RP_____C25 HP_____DC LP_____MAX A_____DC B_____Gnd Gain_____X10K	Connect a 215KΩ resistor between A input and ground	Connect Low 2 output to Ballintine RMS meter		140mv		Record results on 1201 Test Data Sheet
Noise	Same as above except A_____Gnd B_____DC	Connect 215KΩ to B input	Same as above		140mv		

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
Output Impeadences	RP C10 HP DC LP MAX Gain X200 A DC B Gnd Gate Open	10mv rms @ 1KHZ to A input	Monitor front and rear 600Ω output and insure that voltage drops from 2Vrms to 1V rms when outputs are loaded with 600Ω. Then check that voltage goes from 2Vrms to 1Vrms when low 2 output is loaded with 50Ω Check X1 output for 10mVrms				
"Battery test" lamp.	N/A	N/A	With battery removed, insure that test lamp does not illuminate when the battery test switch is operated.				

TEST FUNCTION	SET CONTROLS	INPUT CONDITIONS	OPERATION	TEST LIMITS MIN	TYP	MAX	COMMENTS
Line Interference	RP_____C10 HP_____DC LP_____MAX Gain_____X1K A_____Gnd B_____Gnd Gate_____Open	Connect X1 output to a spectrum analyzer. Observe 60, 120, and 180HZ. Then rotate the transformer T1, to minimize the amplitude of each frequency component. Minimize both 60 and 180Hz simultanasusly, getting the lowest amplitude for each. Then lock the transformer using "lock tight".					

SECTION 8

REPLACEABLE PARTS

8.1 INTRODUCTION

This section contains the information needed for ordering replacement parts.

8.2 REFERENCE DESIGNATIONS AND ABBREVIATIONS

Table 8.1 is a list of reference designations and abbreviations.

8.3 REPLACEABLE PARTS

Table 8.2 lists parts in alphabetical order of their reference designations with locations and descriptions for each part.

8.3.1 EXPLANATION OF LOCATION COLUMN

Each page of Table 8.2 has at the top of the page the description and the ITHACO Drawing Number for the parts listed.

The location code is broken down as follows:

LOCATION		
Sch	Asm	The first digit or (digits) is the page number of the schematic. The letter and digit following locate the part on that particular schematic.
3D9	C9	The letter and number under the assembly column locate the part on the assembly drawing.

8.4 CODE LIST OF MANUFACTURERS

Table 8.3 is a Code List of Manufacturers. The manufacturer's code is given with each part. If a code number is missing, the part is a standard designation and is available from many manufacturers.

REFERENCE DESIGNATIONS

A	assembly subassembly, separable or repairable
AR	amplifier
AT	attenuator pad termination
B	blower motor synchro
BT	battery
C	capacitor
CB	circuit breaker
CP	adapter, connector coupling (aperture, loop or probe) junction (coaxial or waveguide)
CR	diode rectifier
DS	alarm indicator (excluding meter)
E	antenna arrester, lightning bimetallic strip cell, aluminum or electrolytic contact core, inductor core, memory core, transformer Hall effect device insulator loop antenna magnet, permanent part, miscellaneous electrical post, binding shield, electrical terminal (individual)
F	fuse
FL	filter
G	chopper, electronic generator
H	hardware
HR	heater lamp, infrared
HS	handset
HY	network, hybrid circuit
J	connector, receptacle, electrical disconnecting device jack receptacle (connector, stationary portion)
K	relay
L	coil (all not classified as transformers) inductor
M	clock counter, electrical meter oscillograph oscilloscope recorder, elapsed time register, message strain gage thermometer timer, electric
MK	microphone
MP	frame gyroscope interlock, mechanical mechanical part mounting (not electrical circuit, not a socket) part, miscellaneous mechanical (bearing, coupling, gear, shaft) part, structural reed, vibration tuning fork
MT	transducer transducer, mode
P	connector, plug, electrical disconnecting device (connector, plug)
	plug, electrical (connector, movable portion)
PS	power supply
Q	transistor
R	potentiometer resistor
RT	lamp, resistance resistor, current regulating resistor, thermal thermistor
RV	resistor, voltage sensitive varistor, symmetrical
S	switch thermostat
T	transformer
TB	strip, terminal terminal board
TC	thermocouple
TP	test point
U	integrated circuit package
V	cell, light-sensitive, photo-emissive electron tube
W	cable cable assembly (with connectors) wire
WT	tiepoint, wiring
X	fuseholder lampholder socket
Y	crystal unit, piezoelectric

ABBREVIATIONS

A	ampere
AC	alternating current
ALUM	aluminum
AMPL	amplifier
ASSY	assembly
BP	bandpass
CAL	calibration
CAR	carbon
CCW	counterclockwise
CER	ceramic
CKT	circuit
COMP	composition
CRT	cathode-ray tube
CW	clockwise
dB	decibel
DC	direct current
DET	detector
DVM	digital voltmeter
ELECT	electrolytic
ENCAP	encapsulated
EXT	external
F	farads
FET	field effect transistor
FREQ	frequency
FXD	fixed
GE	germanium
GL	glass
GND	ground
H	henries
HPF	high-pass filter
HR	hour
Hz	hertz
IF	intermediate frequency
INS	insulation(ed)
INT	internal
K	kilo = 1000
LED	light emitting diode
LIN	linear taper
LOG	logarithmic taper
LPF	low-pass filter
M	Millo 10^{-3}
MEG	meg 10^{6}
METFLM	metal film
MFR	manufacturer
MINAT	miniature
MOM	momentary
MTG	mounting
MYFLM	"mylar" film
N	nano (10^{-3})
N/C	normally closed
NE	neon
N/O	normally open
NPO	negative positive zero
NSR	not separately replaceable
OSC	oscillator
OP	operational
PC	printed circuit
PF	picofarads 10^{12} farads
PIV	peak inverse volt voltage
P/P	part of
PPM	parts per million
POLY	polystyrene
POLYCARB	poly carbonate
POS	position(s)
POT	potentiometer
P-P	peak-to-peak
RC	resistor capacitor network
RECT	rectifier
REF	reference
RF	radio frequency
RMS	root-means-square
S-B	slow-blow
SCR	screw
SE	selenium
SEC	second
SECT	section(s)
SEMICON	semiconductor
SI	silicon
SIL	silver
SL	slide
SOL	solid
SPL	special
TA	tantalum
TGL	toggle
TOL	tolerance
TRIM	trimmer
μ	micro 10^{-6}
V	volt
VAR	variable
VDCW	dc working volts
VCO	voltage controlled oscillator
W/	with
W	watts
WW	wirewound
W/O	without

TABLE 6.1 LIST OF REFERENCE DESIGNATIONS AND ABBREVIATIONS

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			CAPACITORS			
C1	1-D3	D1	.22μF, 200V, 2%	811540076	104	H2-224B
C2	1-E3	C1	.22μF, 200V, 2%	811540076	104	H2-224B
C3	1-B4	D2	.01μF, 500V, 20%	811570019	48	5GAS-S10
C4	1-C5	D4	0.8pF, to 5.5pF	811590015	105	NVC10GW-TT
C5	1-C6	C3	4.7μF, 10V, 10%	811504038	48	196D-475X9010HA1
C6	1-B6	C4	.01μF, 500V, 20%	811570019	48	5GAS-S10
C7	1-F2	B2	1000pF, 1000V, 20%	811572019	48	56A-D10
C8	1-A8	C5	.01μF, 500V, 20%	811570019	48	5GAS-S10
C9	1-A9	C5	150pF, 1000V, 20%	811572012	48	10TS-T15
C10	1-B9	C5	1000pF, 1000V, 20%	811572019	48	56A-D10
C11	1-D9	B5	330pF, 500V, 5%, Mica	811581037	17	CD15ED330J03
C12	1-D9	B5	330pF, 500V, 5%, Mica	811581037	17	CD15ED330J03
C13	1-D8	C4	3pF, 500V, 1.5pF	811581036	17	CD15CD030D03
C14	1-D8	B5	.01μf, 500V, 20%	811570019	48	5GAS-S30
C15	1-F8	B5	22pF, 500V, 5%	811581043	17	CD15ED220J03
C16	1-E10	B3	33μF, 10V, 10%	811501067	48	150D336X9010B2
C17	2-B2	B6	2.2μF, 10V, 10%	811501146	48	150D225X9020A2
18	2-B2	B7	.22μF, 200V, 10%	811553008	22	W230B1C-224K
C19	2-C2	B7	.22μF, 200V, 10%	811553008	22	W230B1C-224K
C20	2-C2	B6	2.2μF, 20V, 10%	811501146	48	150D225X9020A2
C21	3-F2	G4	10pF, 1000V, 20%	811572001	48	10TS-Q10
C22	3-F5	F7	.033, 100V, 10%	811551016	28	61F17AA333
C23	3-G5	F8	.033, 100V, 10%	811551016	28	61F17AA333
C24	3-G5	E8	1000pF, 1000V, 20%	811572019	48	56A-D10
C25	3-E3	G4	100pF, 500V, 5%	811581008	17	CD15FD101J03
C26	3-B4	G2	5μF, 100V, 5%	811553027	104	D1-505D
C27	3-B3	G3	1.5μF, 100V, 5%	811553022	104	D1-155D
C28	3-B4	G3	0.5μF, 200V, 5%	811553023	104	D2-504D
C29	3-B4	G2	0.15μF, 200V, 5%	811553024	104	D2-154D
C30	3-C3	G2	0.05μF, 200V, 5%	811553025	104	D2-503D
C31	3-C4	G3	.015μF, 100V, 5%	811551037	28	61F15AC153
C32	3-C3	G3	.005μF, 400V, 5%	811553026	104	D4-502
C33	3-D3	F2	1500pF, 500V, 5%	811581070	17	CD19FD152F03
C34	3-D4	F2	470pF , 500V, 5%	811581058	17	CD19FD471J03
C35	3-D4	F2	100pF, 500V, 5%	811581008	17	CD15FD101J03

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			CAPACITORS (Continued)			
C36	1-D6	D3	Select in Test			
C37	4-C1	D8	2pF, 500V, ±.5pF	811581006	17	CD15CD020DO3
C38	4-D1	D7	5pF, 500V, ±.5pF	811581038	17	CD15CD050DO3
C39	4-C3	B8	100pF, 1000V, 20%	811572011	48	10TS-T10
C40	4-D2	D7	5pF, 500V, ±.5pF	811581038	17	CD15CD050DO3
C41	4-D2	D7	2pF, 500V, ±.5pF	811581006	17	CD15CD020DO3
C42	4-F1	D6	4.7µF, 10V, 10%	811504038	48	196D-475X9010HA1
C43	4-G2	E7	10pF, 1000V, 20%	811572001	48	10TS-Q10
C44	4-C3	B9	.01µF, 500V, 20%	811570019	48	5GAS-S10
C45	4-C3	B8	68pF, 1000V, 20%	811572008	48	10TS-Q68
C46	4-C5	B8	68pF, 1000V, 20%	811572008	48	10TS-Q68
C47	4-D4	C6	150pF, 1000V, 20%	811572012	48	10TS-T15
C48	4-C5	C6	.01µF, 500V, 20%	811570019	48	5GAS-S10
C50	4-E5	C6	1000pF, 1000V, 20%	811572019	48	5GAS-S10
C51	4-E5	E6	15pF, 500V, 5%	811581010	17	CD10CD150J03
C52	4-F4	E6	47pF, 500V, 5%	811581004	17	CD15ED470JO3
C53	4-G6	E6	2pF, 500V, ±.5pF	811581006	17	CD15CD020DO3
C54	4-F6	E6	22pF, 500V, ±.5pF	811581066	17	CD10ED220DO3
C55	4-D8	F7	.033µF, 100 V, 10%	811551016	28	61F17AA333
C56	4-D9	F8	1000pF, 1000V, 20%	811572019	48	5GAS-S10
C57	4-C9	F8	.033µF, 100 V, 10%	811551016	28	61F17AA333
C58	4-E9	C8	2.2µF, 20V, 10%	811501146	48	150D225x9020A2
C59	4-G6	E6	2pF, 500V, ±.5pF	811581006	17	CD15CD020DO3
C60	4-G9	C8	2.2µF, 20V, 10%	811501146	48	150D225x9020A2
C63	3-B7	F2	5µF, 100V, 5%	811553027	104	D1-505D
C64	3-B6	F3	1.5µF, 100V, 5%	811553022	104	D1-155D
C65	3-B6	F3	0.5µF, 200V, 5%	811553023	104	D2-504D
C66	3-C7	F2	0.15µF, 200V, 5%	811553024	104	D2-154D
C67	3-C6	F2	0.05µF, 200V, 5%	811553025	104	D2-503
C68	3-C6	F3	.015µF, 100V, 5%	811551037	28	61F15AC153
C69	3-C7	F3	.005µF, 400V, 5%	811553026	104	D4-502
C70	3-D6	E4	.005µF, 400V, 5%	811553026	104	D4-502

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			CAPACITORS (Continued)			
C71	3-D7	E3	.005μF, 400V, 5%	811553026	104	D4-502
C72	3-D7	E3	.0033μF, 100V, 5%	811551036	28	61F10AC332
C73	3-E6	E3	.0033μF, 100V, 5%	811551036	28	61F10AC332
C77	3-E2	F4	8-50pF, VAR	811590014	25	557-019E
C78	1-C10	C6	.01μF, 500V, 20%	811570019	48	5GAS-S10
C79	1-D10	C5	.01μF, 500V, 20%	811570019	48	5GAS-S10
C80	1-D9	C5	.01μF, 500V, 20%	811570019	48	5GAS-S10
C81	1-B5	E3	56pF, 500V, 5%	811581076	79	DM15D560J
C82	1-B5	E3	5.5-18pF (VAR)	811590008	25	538-002A5.5-18
C83	1-B7	C3	68pF, 500V, 2%	811581047	17	CD15ED680G03
C84	1-D5	D3	0.8pF-5.5pF (VAR)	811590015	105	NVC10GW-TT
C85	1-A7	B6	47μF, 20V, 10%	811504021	48	196D-476-9020-LA3
C86	1-A8	B6	1000pF, 1000V, 20%	811572019	48	56A-D10
C87	1-F8	B5	10pF, 1000V, 20%	811572001	48	10TS-Q10
C88	1-G8	B6	1000pF, 1000V, 20%	811572019	48	56A-D10
C89	1-G8	B6	47μF, 20V, 10%	811504021		
C90	2-B1	B6	150pF, 1000V, 20%	811572012	48	10TS-T15
C91	2-C1	B6	150pF, 1000V, 20%	811572012	48	10TS-T15
C92	2-B4	B7	1000pF, 1000V, 20%	811572019	48	56A-D10
C93	2-C4	B7	1000pF, 1000V, 20%	811572019	48	56A-D10
C94	2-H1	E4	1000pF, 1000V, 20%	811572019	48	56A-D10
C95	2-G2	D4	68pF, 1000V, 20%	811572008	48	10TS-Q68
C96	2-G5	D5	68pF, 1000V, 20%	811572008	48	10TS-Q68
C97	3-C5	F4	1000pF, 1000V, 20%	811572019	48	56A-D10
C98	3-C5	F5	47pF, 500V, 5%	811581004	17	CD15ED470J03
C100	3-D6	F4	.01μF, 500V, 20%	811570019	48	5GAS-S10
C102	3-D6	F4	.01μF, 500V, 20%	811570019	48	5GAS-S10
C103	3-D6	F5	.01μF, 500V, 20%	811570019	48	5GAS-S10
C104	3-G2	G6	100pF, 1000V, 20%	811572011	48	10TS-T10
C105	3-F2	G5	100pF, 1000V, 20%	811572011	48	10TS-T10

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			CAPACITORS (Cont)			
C106	3-G3	G6	100pF, 1000V, 20%	811572011	48	10TS-T10
C107	3-G3	G6	100pF, 1000V, 20%	811572011	48	10TS-T10
C108	4-D1	D8	3pF, 500V, ±.5pF	811581036	17	CD15CD030D03
C109	4-D2	D7	3pF, 500V, ±.5pF	811581036	17	CD15CD030D03
C110	4-G5	E6	150pF, 1000V, 20%	811572012	48	10TS-T15
C111	4-E8	C8	47µF, 20V, 10%	811501162	48	150D476x9020R2
C112	4-G7	D8	47µF, 20V, 10%	811501162	48	150D476x9020R2
C113	2-G1	D9	100pF, 500V, 5%	811581008	48	CD15FD101J03
C114	3-E5	F5	47µF, 20V, 10%	811504021	48	196D-476x9020LA3
C115	4-B6	B8	5pF, 500V, ±.5pF	811581038	48	CD15CD050D03
C116	1-E2	B2	47µF, 20V, 10%	811504021	48	196D-476x9020LA3
			DIODES			
CR1	1-F3	B2	IN4148	818100003		IN4148
CR2	1-C4	E2	IN5362	818150049		IN5362
CR3	1-C4	E2	IN4005	818100007		IN4005
CR4	1-C5	D2	A86003-P1	A86003-P1	31	A86003-P1
CR5	1-D4	C2	A86003-P1	A86003-P1	31	A86003-P1
CR6	1-D6	E2	A86003-P1	A86003-P1	31	A86003-P1
CR7	1-C6	E2	In4148	818100003		IN4148
CR8	1-C9	C5	IN4148	818100003		IN4148
CR9	1-C9	C5	IN4148	818100003		IN4148
CR10	1-F8	B4	IN4148	818100003		IN4148
CR11	1-F8	B5	IN4148	818100003		IN4148
CR12	1-F8	B5	IN4148	818100003		IN4148
CR13	1-F8	B5	IN4148	818100003		IN4148
CR14	1-G9	B5	IN4148	818100003		IN4148
CR15	1-E10	B3	IN4148	818100003		IN4148

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			DIODES (Continued)			
CR16	1-F10	B2	IN4148	818100003		IN4148
CR17	1-F10	B2	IN823A	818175002		IN823A
CR18	2-A1	B6	IN4148	818100003		IN4148
CR19	2-B1	B4	IN4148	818100003		IN4148
CR20	2-B1	C9	IN4148	818100003		IN4148
CR21	2-B1	B6	IN4148	818100003		IN4148
CR22	2-C1	B4	IN4148	818100003		IN4148
CR23	2-C1	C9	IN4148	818100003		IN4148
CR24	2-B3	B7	IN4148	818100003		IN4148
CR25	2-A2	B8	IN4148	818100003		IN4148
CR26	2-A3	B7	IN4148	818100003		IN4148
CR28	2-E7	E5	IN4148	818100003		IN4148
CR29	2-F7	E5	IN4148	818100003		IN4148
CR30	2-G7	E6	IN4148	818100003		IN4148
CR31	4-B3	B8	IN4148	818100003		IN4148
CR32	4-B3	B8	IN4148	818100003		IN4148
R33	4-C4	B8	IN4148	818100003		IN4148
CR34	4-C5	B8	IN4148	818100003		IN4148
CR35	4-H3	D7	IN4148	818100003		IN4148
CR36	4-H3	D7	IN4148	818100003		IN4148
CR37	4-F8	C8	IN4148	818100003		IN4148
CR38	4-G8	D8	IN4148	818100003		IN4148
CR39	1-G5	E3	IN4148	818100003		IN4148
CR42	4-E1	D6	IN4148	818100003		IN4148
CR43	4-E1	D6	IN4148	818100003		IN4148
CR44	1-D5	D2	A86003P1	A86003P1	31	A86003P1
CR45	1-D7	C2	A86003P1	A86003P1	31	A86003P1
CR46	1-B6	C3	IN4148	818100003		IN4148
CR47	1-B7	C3	IN4148	818100003		IN4148
CR48	1-D8	B5	IN4148	818100003		IN4148
CR49	1-E7	B5	IN4148	818100003		IN4148
CR50	1-E7	B5	IN4148	818100003		IN4148

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
CR51	2-G2	D4	IN753A	818150005		IN753A
CR52	2-G2	D4	IN4148	818100003		IN4148
CR53	2-G3	D4	IN4148	818100003		IN4148
CR54	2-G5	D5	IN4148	818100003		IN4148
CR55	3-D5	F4	IN4148	818100003		IN4148
CR56	3-D5	F5	IN4148	818100003		IN4148
CR57	4-F4	C7	IN4148	818100003		IN4148
CR58	3-C4	G4	IN4148	818100003		IN4148
L1	1-C4	D2	Choke - 33μh	811800021	20	1537-24
L2	1-D4	C2	Choke - 33μh	811800021	20	1537-24
L3	1-A5	E2	Choke - Ferrite Bead	811800014	51	1568
L4	1-B7	D3	Choke - Ferrite Bead	811800014	51	1568
L5	1-B8	C3	Choke - Ferrite Bead	811800014	51	1568
K1	1-F3	D2	Relay, Tube-Reed	814500018	106	2A12AE-1
K2	1-D6	D3	Relay, Merc	814500019	107	378725
K3	3-D9	E2	Relay, Tube-Reed	814500020	106	1A12AE-1
K4	4-C2	D7	Relay, Reed	814500021	106	122LX1KOBAA
K5	4-B5	C8	Relay, Reed	814500021	106	122L X1KOBAA
K6	4-D6	F6	Relay, Reed	814500021	106	122LX1KOBAA
			TRANSISTORS			
Q1	1-A5	E2	2N3904	818203904		2N3904
Q2	1-B5	E2	2N3904	818203904		2N3904
Q3	1-B6	C4	2N3906	818203906		2N3906
Q4	1-C6	D3	U402	818700043	108	U402
Q5	1-D5	D3	2N6483	818206483		2N6483
Q6	1-D6	E2	2N5087	818205087		2N5087
Q7	1-B7	D3	AD821	818700045		AD821
Q8	1-C8	B4	2N3904	818203904		2N3904
Q9	1-A8	C5	2N3906	818203906		2N3906
Q10	1-B9	C5	2N3906	818203906		2N3906

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			TRANSISTORS (Continued)			
Q11	1-B9	C5	2N3904	818203906		2N3904
Q12	1-C8	C4	A D821	818700045	5	AD821
Q13	1-C9	B4	2N3906	818203906		2N3906
Q14	1-C8	B5	2N3904	818203904		2N3904
Q15	1-C9	C6	2N3906	818203906		2N3906
Q16	1-C10	C6	2N3904	818203904		2N3904
Q17	1-D10	C5	2N3906	818203906		2N3906
Q18	1-D9	C5	2N3906	818203906		2N3906
Q19	1-F8	B4	2N3904	818203904		2N3904
Q20	1-F8	B4	2N3906	818203906		2N3906
Q21	1-F8	B5	AD821	818700045	5	AD821
Q22	1-G8	B5	2N3904	818203904		2N3904
Q23	1-F9	B2	2N3904	818203904		2N3904
Q24	2-B2	B6	2N3904	818203904		2N3904
Q25	2-B3	B7	2N3904	818203904		2N3904
Q26	2-C3	C7	2N3904	818203904		2N3904
Q27	2-B3	B7	2N3906	818203906		2N3906
:8	2-C3	B7	2N3906	818203906		2N3906
Q29	2-C2	B6	2N3906	818203906		2N3906
Q30	2-F3	D5	2N3906	818203906		2N3906
Q31	2-F4	D5	2N3906	818203906		2N3906
Q32	2-G3	D5	2N3904	818203904		2N3904
Q33	2-G4	D5	2N3904	818203904		2N3904
Q34	2-E3	D4	TIS-75	818700009	55	TIS-75
Q35	2-E5	D5	TIS-75	818700009	55	TIS-75
Q36	2-C4	C7	2N3906	818203906		2N3906
Q37	2-B4	B7	2N3904	818203904		2N3904
Q38	2-A4	B7	2N3906	818203906		2N3906
Q39	2-C5	B8	2N3906	818203906		2N3906
Q40	2-C4	B7	2N3904	818203904		2N3904
Q41	2-B5	B8	2N3904	818203904		2N3904
Q42	2-D5	B8	2N3904	818203904		2N3904
Q43	2-E7	E4	TIS-75	818700009	55	TIS-75
Q44	2-E7	E5	TIS-75	818700009	55	TIS-75
Q45	2-F7	E5	TIS-75	818700009	55	TIS-75

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			TRANSISTORS (Continued)			
Q46	2-G7	E6	TIS-75	818700009	55	TIS-75
Q47	3-F6	F7	2N3904	818203904		2N3904
Q48	3-G6	G7	2N3906	818203906		2N3906
Q49	3-G6	G7	2N 3904	818203904		2N3904
Q50	3-G6	G7	2N3906	818203906		2N3906
Q52	4-B2	B9	2N3904	818203904		2N3904
Q53	4-B2	B9	2N3904	818203904		2N3904
Q54	4-C2	B9	2N3906	818203906		2N3906
Q55	4-C2	C9	2N3906	818203906		2N3906
Q56	4-E2	D6	2N3906	818203906		2N3906
Q57	4-E2	D6	E411	818700042	108	E411
Q58	4-F1	D6	U402	818700043	108	U402
Q59	4-F2	D6	2N3906	818203906		2N3906
Q60	4-G2	D6	2N3904	818203904		2N3904
Q61	4-H2	D7	2N3906	818203906		2N3906
Q62	4-H3	D7	2N3904	818203904		2N3904
Q63	4-G3	E7	AD821	818700045	5	AD821
Q64	4-F2	C7	2N3904	818203904		2N3904
Q65	4-F3	C7	2N3906	818203906		2N3906
Q66	4-G4	C8	2N3904	818203904		2N3904
Q67	4-F4	C8	2N3906	818203906		2N3906
Q68	4-E4	C7	AD821	818700045	5	AD821
Q69	4-E3	D7	AD821	818700045	5	AD821
Q70	4-C3	B9	2N3906	818203906		2N3906
Q71	4-C4	B8	AD821	818700045	5	AD821
Q72	4-D4	C6	2N3906	818203906		2N3906
Q73	4-D5	D6	2N3906	818203906		2N3906
Q74	4-D5	C6	2N3904	818203904		2N3904
Q75	4-B7	F7	2N3904	818203904		2N3804
Q76	4-B7	F7	2N3906	818203906		2N3906
Q77	4-B7	F7	2N3904	818203904		2N3904
Q78	4-C7	F7	2N3906	818203906		2N3906
Q79	4-G7	D8	2N3906	818203906		2N3906
Q80	4-F8	D9	2N3904	818203904		2N3904

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			TRANSISTORS (Continued)			
Q81	4-F8	C9	2N2219	818202219		2N2219
Q82	4-G8	D9	2N3906	818203906		2N3906
Q83	4-G8	D9	2N2905	818202905		2N2905
Q84	2-G5	D5	2N3906	818203906		2N3906
Q85	1-G5	E3	2N3904	818203904		2N3904
Q86	1-G5	E3	2N3906	818203906		2N3906
Q87	2-G3	D5	2N3904	818203904		2N3904
Q88	1-C8	C4	2N3906	818203906		2N3906
Q89	1-D8	C5	2N3904	818203904		2N3904
Q90	1-D9	B5	2N3904	818203904		2N3904
Q91	2-E3	D4	2N3904	818203904		2N3904
Q92	2-E3	D5	TIS-75	818700009	55	TIS-75
Q93	2-E4	D5	2N3904	818203904		2N3904
Q94	2-E5	D5	TIS-75	818700009	55	TIS-75
Q95	2-G4	D5	2N3904	818203904		2N3904
Q96	2-E7	E4	2N3904	818203904		2N3904
Q97	2-F7	E5	2N4351	818204351		2N4351
[illegible]8	2-F7	E5	2N4351	818204351		2N4351
Q99	2-G7	E5	2N4351	818204351		2N4351
Q100	3-F2	G4	2N5464	818205464		2N5464
Q102	3-C5	G5	2N3906	818203906		2N3906
Q103	3-D4	G5	U402	818700043	105	U402
Q104	3-D5	G5	2N3904	818203904		2N3904
Q105	3-C5	F4	2N3904	818203904		2N3904
Q106	3-D6	F4	2N3904	818203904		2N3904
Q107	3-D5	F5	2N3904	818203904		2N3904
Q108	3-D6	F5	2N3906	818203906		2N3906
Q109	4-G4	C7	2N3904	818203904		2N3904
Q110	4-G4	C7	2N3904	818203904		2N3904
Q111	4-E8	D8	2N3906	818203906		2N3906
Q112	4-G8	D8	2N3906	818203906		2N3906
Q113	1-C8	C4	2N3906	818203906		2N3906
[illegible]16	4-F4	D8	2N3906	818203906		2N3906

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			RESISTORS			
			All resistors not otherwise designated are 1/4W, 5%, Comp * 1/8W, 1%, Metflm ** 1/8W, 0.1%, Metflm ***1/10W, 1%, Temp Stable, Metflm			
R1	1-E2	C2	10 ohm, 1W, 5%	817032100		RC32
R6	1-D4	D1	100m, 1/2W , 1%	817200031	57	CGH 1/2 50-100M-
R8	1-D4	C1	100m, 1/2W, 1%	817200031		CGH 1/2 50-100M-
R9	1-E3	C2	10K	817007103		RC07
R10	1-E3	D2	10K	817007103		RC07
R11	1-B5	E2	18K	817007183		RC07
R12	1-B5	E2	500 ohm (pot)	817007752		RC07
R13	1-C4	D2	750 ohm	817007751		RC07
R14	1-E4	C2	750 ohm	817007751		RC07
R15	1-B5	D3	27 ohm	817007270		RC07
R16	1-C5	D2	47 ohm	817007470		RC07G
R17	1-E5	D3	4.87K, 1/4W, .05%	817200032	57	MAR7-T10-4.87K
R18	1-E6	D3	1K, 1/4W, .05%	817200033	57	MAR7-T10-1K
R19	1-B6	D3	8.06K, 1/4W, .05%	817200034	57	MAR7-T10-8.06K
R20	1-B6	C4	13.3K *	817212133		RN60D
R21	1-B6	C3	8.06K, 1/4W, .05%	817200034	57	MAR7-T10-8.06K
R22	1-C6	C3	3.16K *	817212316		RN60D
R23	1-C6	C3	20K (Pot)	817801137	29	78SR20K-BW
R24	1-D6	D2	20 ohm (Pot)	817801103	29	72PR20 ohm
R25	1-F3	C2	68 ohm	817007680		RC07
R26	1-D6	D2	1.18K, 1/4 W, .05%	817200035	57	MAR7-T10-1.18K
R 27	1-D6	C2	1.18K, 1/4W, .05%	817200035	57	MAR7-T10-1.18K
R28	1-D6	C2	6.8K	817007682		RC07
R29	1-E6	C2	110 ohm, 1/4W, .05%	817200036	57	MAR7-T10-110 ohm
R30	1-E6	D4	1K, 1/4W, .05%	817200033	57	MAR7-T10-1K

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
R31	1-F6	D4	.68 ohm, 2W, 5% WW	817002003	64	BWH
R32	1-C6	C3	46.4K *	817212464		RN60D
R33	1-C7	C3	261K *	817213261		RN60D
R34	1-B7	D3	23.7K *	817212237		RN60D
R35	1-B7	C3	23.7K *	817212237		RN60D
R36	1-D7	C2	47 ohm	817007470		RC07
R37	1-G5	E3	100K	817007104		RC07
R40	1-A8	C5	162 ohm *	817210162		RN60D
R41	1-B8	C4	33 ohm	817007330		RC07
R42	1-B9	C4	33 ohm	817007330		RC07
R43	1-B9	C4	2.15K *	817211215		RN60D
R44	1-D8	B4	6.19 K *	817211619		RN60D
R45	1-D7	C3	27 ohm	817007270		RC07
R46	1-E7	C3	4.87K, 1/4W, .05%	817200032	57	MAR7-T10-4.87K
R47	1-E8	B5	2.7K	817007272		RC07
R48	1-F8	B5	2.2K	817007222		RC07
R49	1-F8	B4	68 ohm	817007680		RC07
R50	1-F8	B4	68 ohm	817007680		RC07
R51	1-G8	B6	1K *	817211100		RN60D
R52	1-G9	B6	1K *	817211100		RN60D
R53	1-D8	B5	511 ohm *	817210511		RN60D
R54	1-D8	B5	4.7K	817007472		RC07
R55	1-C9	B5	1K	817007102		RC07
R56	1-D9	B5	511 ohm *	817210511		RN60D
R57	1-E8	B5	422 ohm *	817210422		RN60D
R58	1-F9	B5	2.7K	817007272		RC07
R59	1-E9	B3	2.87K *	817211287		RN60D
R60	1-F9	B3	6.19K *	817211619		RN60D
R61	1-E10	B3	10K	817007103		RC07
R62	1-F9	B2	8.25K *	817211825		RN60D
R63	3-E2	G4	9.09K *	817211909		RN60D
R65	3-E2	G4	2K (Pot)	817801110	29	72PR2K
R66	1-C10	B6	68 ohm	817007680		RC07
R67	1-D10	B6	68 ohm	817007680		RC07
R68	2-A2	B6	1K	817007102		RC07
R69	2-B2	B7	100 ohm	817007101		RC07
R70	2-B2	B7	1K	817007102		RC07

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			RESISTORS (continued)			
R71	2-B2	B7	1.8M,	817007185		RC07
R72	2-C2	B7	100 ohm	817007101		RC07
R73	2-C2	B7	1K	817007102		RC07
R74	2-C2	B7	1.8M	817007185		RC07
R75	2-C2	B6	1K	817007102		RC07
R76	2-G5	D5	33K	817007333		RC07
R77	2-F4	D5	100K	817007104		RC07
R78	2-G5	D5	56K	817007563		RC07
R79	2-G5	D5	33K	817007333		RC07
R80	2-F3	D5	10K	817007103		RC07
R81	3-G2	G6	56K	817007563		RC07
R82	3-H2	G6	56K	817007563		RC07
R83	3-G3	G6	56K	817007563		RC07
R84	3-H3	G6	56K	817007563		RC07
R85	3-H3	G6	4.7K	817007472		RC07
R86	2-B4	B7	33K	817007333		RC07
R87	2-B4	B7	8.25K, *	817211825		RN60D
R88	2-B4	B7	118K *	817213118		RN60D
R89	2-C4	B7	33K	817007333		RC07
R90	2-C2	B7	8.25K *	817211825		RN60D
R91	2-C4	B7	118K *	817213118		RN60D
R92	2-F3	D4	18K	817007183		RC07
R93	2-F4	D5	18K	817007183		RC07
R94	2-D4	B7	330K	817007334		RC07
R95	2-F3	D4	100K	817007104		RC07
R96	2-G2	D4	680K	817007684		RC07
R97	2-F4	D5	10K	817007103		RC07
R98	2-G2	D4	1M	817007105		RC07
R99	2-G2	D4	10K	817007103		RC07
R100	2-G2	D4	1.8M	817007185		RC07
R101	1-G4	E2	680K	817007684		RC07
R102	2-A4	B7	100K	817007104		RC07
R103	2-B4	B8	33K	817007333		RC07
R104	2-C4	B7	100K	817007104		RC07
R105	2-B5	B8	56K	817007563		RC07

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			RESISTORS (continued)			
R106	2-B6	B7	1K	817007102		RC07
R107	2-B5	B8	23.7K *	817212237		RN60D
R108	2-D5	B8	21.5K *	817212215		RN60D
R109	2-D7	E4	1.21K *	817211121		RN60D
R110	2-E7	E4	18K	817007183		RC07
R112	2-E7	E4	100K	817007104		RC07
R113	2-E6	E5	2.495K **	817261182	57	CEA-TO-2.495K 1/8 1%
R114	2-G3	D5	100K	817007104		RC07
R116	2-F6	E5	1.497K **	817261183	57	CEA-TO-1.497K 1/8 1%
R117	2-F7	E5	464 ohm *	817210464		RN60D
R118	2-H2	E4	1K	817007102		RC07
R119	2-F6	E5	499 ohm **	817261178	42	PME55
R120	2-G6	E5	499 ohm **	817261178	42	PME55
R121	2-G8	D6	10M	817007106		RC07
R122	2-G7	E6	825 ohm *	817210825		RN60D
23	3-G5	E8	56K	817007563		RC07
R124	3-F6	F7	100K	817007104		RC07
R125	3-F6	F7	820K	817007105		RC07
R126	3-F6	F7	220K	817007224		RC07
R127	3-G5	E7	1.8M	817007333		RC07
R128	3-G5	F8	100K	817007104		RC07
R131	2-G4	D5	100K	817007104		RC07
R132	2-G4	D5	100 ohm	817007101		RC07
R133	4-B2	C9	220 ohm	817007221		RC07
R134	4-B2	B9	47 ohm	817007470		RC07
R135	4-C2	C9	47 ohm	817007470		RC07
R136	4-D1	D7	33 ohm	817007330		RC07
R137	4-E1	C7	8.06K, 1/8W, .05%	817200034	57	MAR7-T10-8.06K
R138	4-D2	D6	5.11K *	817211511		RN60D
R139	4-D2	D7	33 ohm	817007330		RC07
R140	4-E2	C7	8.06K, 1/8W, .05%	817200034	57	MAR7-T10-8.06K

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			RESISTORS (continued)			
R141	4-F2	D6	13.3K *	817212133		RN60D
R142	4-G1	D6	33 ohm	817007330		RC07
R143	4-G2	D6	33 ohm	817007330		RC07
R144	4-G1	D6	500 ohm (Pot)	817801015	29	66WR500
R145	4-H2	D7	7.5K	817007752		RC07
R146	4-G2	E7	330 ohm	817007331		RC07
R147	4-G2	D7	6.8K,	817007682		RC07
R148	4-H2	D7	100 ohm	817007101		RC07
R149	4-H3	D7	511 ohm *	817210511		RN60D
R150	4-H3	D7	511 ohm *	817210511		RN60D
R151	4-B3	B8	10K	817007103		RC07
R152	4-B3	B8	750 ohm	817007751		RC07
R153	4-B4	B8	16.2K *	817212162		RN60D
R154	4-D3	B8	150 ohm	817007151		RC07
R155	4-C3	B9	2.7K	817007272		RC07
R156	4-D4	B8	23.7K *	817212237		RN60D
R157	4-C5	B8	390 ohm	817007391		RC07
R158	4-D5	C6	162 ohm *	817210162		RN60D
R159	4-E5	C7	2.15K *	817211215		RN60D
R160	4-E4	C7	47 ohm	817007470		RC07
R161	4-E4	C7	47 ohm	817007470		RC07
R162	4-E3	D7	10K *	817007103		RC07
R163	4-E3	D7	10K *	817007103		RC07
R164	4-G2	E7	2.7K	817007272		RC07
R165	4-G3	E7	750 ohm	817007751		RC07
R166	4-F2	C7	6.19K *	817211619		RN60D
R167	4-G3	E7	2.7K	817211272		RN60D
R168	4-G4	C7	511 ohm *	817210511		RN60D
R169	4-G4	C7	4.7K	817007472		RC07
R170	4-G4	C7	511 ohm *	817210511		RN60D
R171	4-F5	D8	150 ohm	817007151		RC07
R173	4-B6	B8	6.65K **	817261179	42	PME55
R174	4-B6	B8	66.5K **	817261180	42	PME55
R175	4-C6	B8	46.4K *	817212464		RN60D

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			RESISTORS (continued)			
R176	4-C6	B8	750.0 ohm **	817261181	42	PME55
R177	4-E6	F7	1M	817007105		RC07
R178	4-E6	F6	220K	817007224		RC07
R179	4-G5	G6	100 ohm *	817210100		RN60D
R180	4-G5	G6	100 ohm (Pot)	817801104	29	68WR100ohm
R181	4-G6	E6	26.1K *	817212161		RN60D
R182	4-G6	E6	2K (pot)	817801108	29	68WR2K
R183	4-F6	E7	1.47K *	817211147		RN60D
R186	4-C9	F8	100K	817007104		RC07
R187	4-C9	E7	1.8M	817007185		RC07
R188	4-D7	F7	100K	817007104		RC07
R189	4-D8	F8	56K	817007563		RC07
R190	4-C9	E7	680K	817007684		RC07
R191	4-E8	C8	4.7K	817007472		RC07
R192	4-E8	C8	750 ohm	817007751		RC07
93	4-E8	C8	100 ohm	817007101		RC07
R194	4-F8	D8	18 ohm	817007180		RC07
R195	4-F9	D9	18 ohm	817007180		RC07
R196	4-F8	D9	18 ohm	817007180		RC07
R197	4-G7	D8	100 ohm	817007101		RC07
R198	4-G8	D8	47 ohm	817007470		RC07
R199	4-G8	D8	100 ohm	807007101		RC07
R200	4-F9	C9	604 ohm *	817200045	57	CEC-TO-604-1%
R201	4-E9	C9	604 ohm *	817200045		CEC-TO-604-1%
R203	1-G5	E3	390 ohm	817007391		RC07
R204	1-B9	C4	1K	817007102		RC07
R205	1-G4	E2	100K	817007104		RC07
R206	1-B5	D3	1.78K *	817211178		RN60D
R207	4-D4	C6	1K	817007102		RC07
R208	1-B7	C3	1.78K *	817211178		RN60D
R209	1-E5	E4	20 ohm (Pot)	817801109	29	68WR 20 ohm
R210	1 C9	B6	4.7K	817007472		RC07

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			RESISTORS (continued)			
R211	1-C9	B6	750 ohm	817007751		RC07
R212	2-H3	D5	33K	817007333		RC07
R213	1-C8	B4	10K	817007103		RC07
R214	1-E8	C4	10 ohm *	817219100		RN60D
R215	2-G2	D4	1K	817007102		RC07
R216	2-G3	D5	100 ohm	817007101		RC07
R217	2-G2	D4	56K	817007563		RC07
R218	2-B2	B7	330K	817007334		RC07
R219	3-D8	E4	1.00M *	817214100		RN60D
R220	3-D8	E4	61.9K *	817212619		RN60D
R221	1-C10	C6	560 ohm, 1/2W, 5%	817020561		RC20GF561J
R222	1-D10	C5	560 ohm, 1/2W, 5%	817020561		RC20GF561J
R223	1-D9	C5	560 ohm, 1/2W, 5%	817020561		RC20GF561J
R224	4-F7	E6	1.21K *	817211121		RN60D
R225	4-G5	G6	287 ohm *	817210287		RN60D
R226	1-G5	E3	56K	817007563		RC07
R227	1-F9	B5	220 ohm	817007221		RC07
R228	2-G5	D5	1.8M	817007185		RC07
R229	3-F2	G4	10M	817007106		RC07
R230	1-F10	B2	56K	817007563		RC07
R231	1-F10	B2	33K	817007333		RC07
R232	3-D4	G4	150 ohm	817007151		RC07
R233	3-C4	G4	4.64K *	817211464		RN60D
R234	3-C5	G4	4.64K *	817211464		RN60D
R235	3-C5	F4	100 ohm	817007101		RC07
R236	3-D4	G4	47 ohm	817007470		RC07
R237	3-D5	F5	390 ohm	817007391		RC07
R238	3-D4	G4	47 ohm	817007470		RC07
R239	3-D4	G4	50 ohm (Pot)	817801105	29	66WR500
R240	3-E5	G5	7.5K	817007752		RC07
R241	3-D5	F4	4.7K	817007472		RC07
R242	3-E5	F5	7.5K	817007752		RC07
R243	3-C6	F4	560 ohm	817020561		RC20GF561J
R244	3-D6	F4	18 ohm	817007180		RC07
R245	3-D6	F5	18 ohm	817007180		RC07

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			RESISTORS (continued)			
R246	3-E6	F5	560 ohm	817020561		RC20GF561J
R247	3-E8	F4	16.2K *	817212162		RN60D
R248	3-E7	E3	51.1K *	817212511		RN60D
R249	3-E8	E3	118K *	817213118		RN60D
R250	3-F7	E4	453K *	817213453		RN60D
R251	3-D9	E2	68 ohm	817007680		RC07
R252	4-E3	D7	100 ohm	817007101		RC07
R253	4-E3	D7	100 ohm	817007101		RC07
R254	4-F3	C7	100 ohm	817007101		RC07
R255	4-F4	C7	100 ohm	817007101		RC07
R256	4-F3	D7	10K,	817007103		RC07
R257	4-H2	D7	33K	817007333		RC07
R258	2-H1	E8	10 ohm, 1W, 5%	817032100		RC32GF100J
R259	3-D9	E4	1K	817007102		RC07
R260	4-D10	G6	4.7K	817007472		RC07
R261	4-H2	D6	220 ohm	817007221		RC07
R262	4-F9	E8	46.4 ohm*	817219464		RN60D
U1	3-F5	F8	CD4069UBE	816374069	36	CD4069UBE
U2	3-G6	F8	CD4081B	816374081	36	CD4069UBE
U3	3-G5	E8	CD4070B	816374070	36	CD4069UBE

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
DS1			LED, Red	818149006	78	521-9165
DS2			LED, Grn	818149007	78	521-9203
			RESISTORS			
R1			20 ohm (Pot)	817801113	7	78SBWR20
R2			10 ohm (Pot)	817801112	7	78SBWR10
R4			51.1 ohm, 1/8W, 1%	817219511		RN60D
R5			51.1 ohm, 1/8W, 1%	817219511		RN60D
R6			51.1 ohm, 1/8W, 1%	817219511		RN60D
R7			51.1 ohm, 1/8W, 1%	817219511		RN60D

TABLE 8.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			CAPACITORS			
C1	1-D4	C4	1000μF, 50V	811530020	17	BR-1000-50
C2	1-C5	E4	1000μF, 50V	811530020	17	BR-1000-50
C3	1-C5	D3	2.2μF, 20V, 10%	811501146	48	150D225x9020A2
C4	1-D6	D4	470pF, 1000V, 10%	811572015	17	10TS-T47
C5	1-D6	D2	2.2μF, 20V, 10%	811530020	17	BR-1000-50
C6	1-F4	D4	33pF, 1000V, 10%	811572004	17	10TS-Q33
C7	1-F4	C5	.01μF, 500V, 20%	811570019	17	5GA-D10
C8	1-G4	C3	15μF, 20V, 10%	811501156	48	150D225x9020A2
C9	1-E9	C2	33pF, 1000V, 10%	811572004	17	10TS-Q33
C10	1-F9	C3	2.2μF, 20V, 10%	811530020	17	BR-1000-50
C11	1-A7	D3	470pF, 1000V, 10%	811570015	17	10TS-T47
C12	1-F7	C2	470pF, 1000V, 10%	811572015	17	10TS-T47
			DIODES			
CR1	1-B4	D5	IN4005	818100007		IN4005
CR2	1-C4	D5	IN4005	818100007		IN4005
CR3	1-C4	C5	IN4005	818100007		IN4005
CR4	1-D4	C5	IN4005	818100007		IN4005
CR5	1-B7	D3	IN4005	818100007		IN4005
CR6	1-B8	E2	IN4005	818100007		IN4005
CR7	1-D7	D2	IN4005	818100007		IN4005
CR8	1-G3	C3	IN4005	818100007		IN4005
CR10	1-F5	C3	IN4005	818100007		IN4005
CR11	1-F8	C2	IN4005	818100007		IN4005
CR12	1-E8	C3	IN5234	818150073		IN5234
F1	1-C8	D2	Fuse 1.5A FA	815183013	9	AGC
F2	1-F6	D2	Fuse 1.5A FA	815183013	9	AGC
Q2	1-B7	E2	2N3904 Transistor	818203904		2N3904
Q4	1-G3	C4	2N3904 Transistor	818203904		2N3904
Q6	1-F4	C4	2N3906 Transistor	818203906		2N3906
Q7	1-E7	C2	2N3904 Transistor	818203904		2N3904

TABLE 8.2 REPLACEABLE PARTS

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
			RESISTORS All resistors not otherwise designated are 1/4W, 5%, Comp. * 1/8W, 1%, Metflm ** 1/8W, 0.1%, Metflm ***1/10W, 1%, Temp Stable, Metflm			
R1	1-C5	D3	4.7K	817007472		RC07
R2	1-C6	D4	1.2 ohm	817003129	57	BW20F1.2 ohm
R3	1-C6	D3	10.0K *	817212100		RN60
R4	1-D6	D3	6.65K *	817211665		RN60
R5	1-D6	D3	2K Pot	817801110	84	72PR2K
R6	1-D7	D2	4.7K	817007472		RC07
R7	1-A7	E3	3.3K	817020332		RC20
R8	1-B8	E2	8.2 ohm	817007829		RC07
R9	1-B8	E2	6.8 ohm	817007689		RC07
R10	1-B6	D4	75K	817007753		RC07
R11	1-E6	C4	10.0K *	817212100		RN60
R12	1-G3	C3	1.2 ohm	817003129	57	BW20F1.2 ohm
R13	1-F3	C4	4.7K	817007472		RC07
R14	1-F4	C4	10.0K *	817212100		RN60
R15	1-E4	C4	15K	817007153		RC07
R16	1-E5	C4	15K	817007153		RC07
R17	1-E5	C4	15K	817007153		RC07
R18	1-F6	C4	4.7K	817007472		RC07
R19	1-F7	C2	8.2K	817007822		RC07
R20	1-E7	C2	8.2 ohm	817007829		RC07
R21	1-E8	C2	5.6 ohm	817007569		RC07
R22	1-D8	C3	2K Pot	817801110	84	72PR2K
R23	1-E9	C3	3.3K	817007332		RC07
R24	1-E8	C3	1K	817007102		RC07
R25	1-E8	C3	680 ohm	817007681		RC07
R26	1-F8	C3	3.3K	817007332		RC07
R27	1-E9	C2	180K	817007184		RC07
R28	1-E9	C2	470 ohm	817020471		RC20
R29	1-C6	D4	1K	817007102		RC07
R30	1-G3	C4	1K	817007102		RC07

REFERENCE DESIGNATION	LOCATION SCH	LOCATION ASM	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
R31	1-F3	C4	75K	817007753		RC07
R32	1-B7	E2	1K	817007102		RC07
R33	1-E7	C2	1K	817007102		RC07
U1	1-C5	D4	Regulator LM723CN	816400074		LM723CN
U2	1-E4	C4	Op Amp LM301A	A86050-P4	31	LM301A
U3	1-E9	C2	Op Amp LM301A	A86050-P4	31	LM301A

TABLE 8.2 REPLACEABLE PARTS

REPERENCE DESIGNATION	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
	Capacitors			
C1				
C2	.01µF, 500V, 20%	811570019	48	5GAS-S10
C3	15µF, 20V, 10%	811504020	48	196D-156X9020KA1
	Diodes			
CR1	IN4148, SI	818100003		IN4148
CR2	IN4148, SI	818100003		IN4148
CR3	IN4148, SI	818100003		IN4148
CR4	IN4148, SI	818100003		IN4148
CR5	IN4148, SI	818100003		IN4148
CR6	IN4148, SI	818100003		IN4148
CR7	IN4148, SI	818100003		IN4148
CR8	IN4148, SI	818100003		IN4148
CR9	IN4148, SI	818100003		IN4148
CR10	IN4148, SI	818100003		IN4148
CR11	IN4148, SI	818100003		IN4148
CR12	IN4148, SI	818100003		IN4148
CR13	IN4148, SI	818100003		IN4148
CR14	IN4148, SI	818100003		IN4148
CR15	IN4148, SI	818100003		IN4148
CR16	IN4148, SI	818100003		IN4148
CR17	IN4148, SI	818100003		IN4148
CR18	IN4148, SI	818100003		IN4148
CR19	IN4148, SI	818100003		IN4148
CR20	IN4148, SI	818100003		IN4148
CR21	IN4148, SI	818100003		IN4148
CR22	IN4148, SI	818100003		IN4148
CR23	IN4148, SI	818100003		IN4148
CR24	IN5246A, Zener, 16V, ±5%	818150017		IN5246A
CR25	IN4148, SI	818100003		IN4148
CR26	IN4148, SI	818100003		IN4148
CR27	IN5234, Zener, 6.2V, ±5%	818150023		IN5234
CR28	IN4148, SI	818100003		IN4148
CR29	IN4148, SI	818100003		IN4148
	Connectors			
J1	36 Pin	812122014	4	552742-1
	Transistors			
Q1	NPN	818203904		2N3904
Q2	NPN	818203904		2N3904
Q3	PNP	818203906		2N3906
Q4	PNP	818203906		2N3906
Q5	PNP	818203906		2N3906
Q6	PNP	818203906		2N3906
Q7	NPN	818203904		2N3904
Q8	NPN	818203904		2N3904
Q10	PNP	818203906		2N3906
Q11	PNP	818203906		2N3906
Q12	NPN	818203904		2N3904
Q13	NPN	818203904		2N3904
Q14	NPN	818203904		2N3904

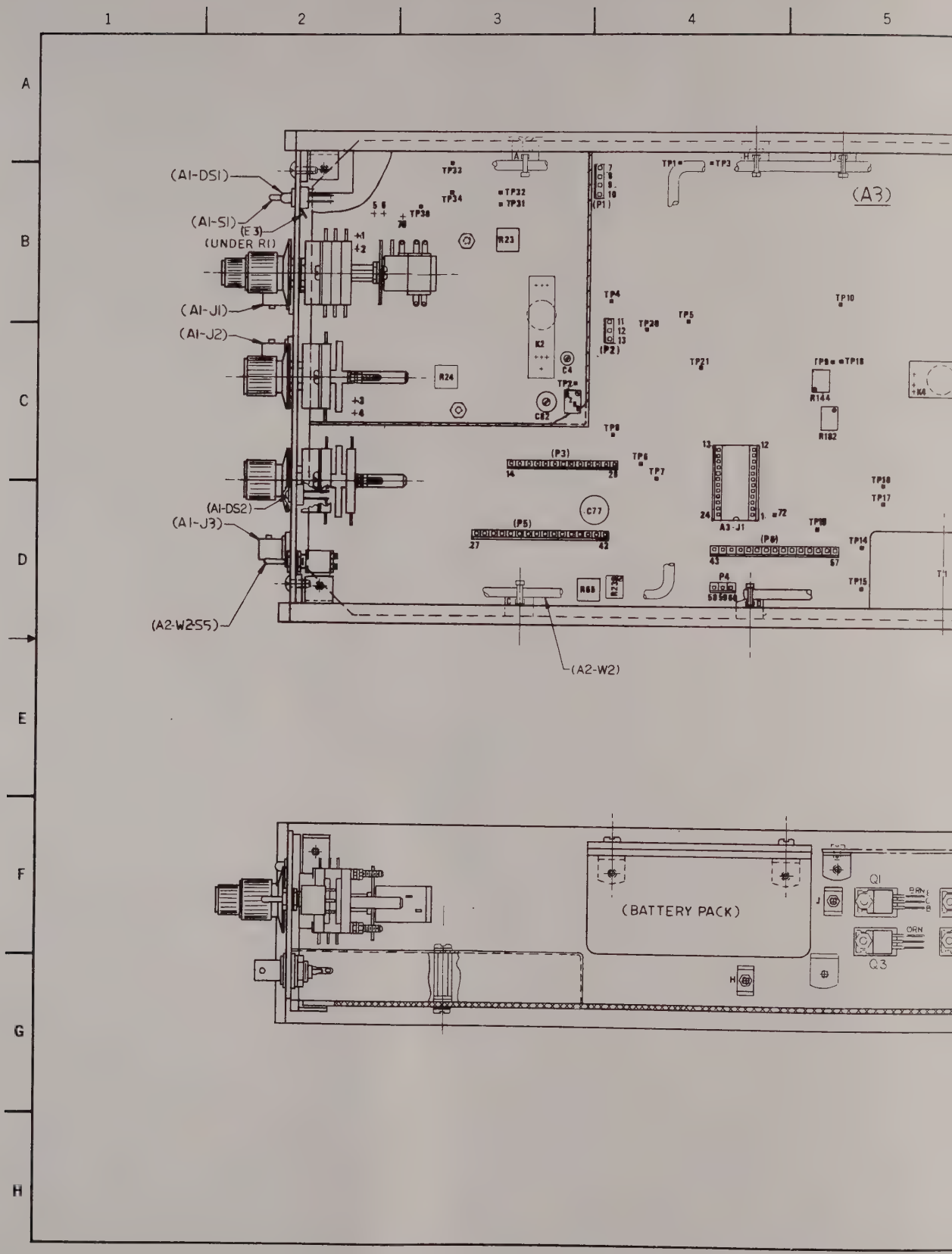
REFERENCE DESIGNATION	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
	Transistors (con't)			
Q15	NPN	818203904		2N3904
Q16	Network	818700050	100	CA3081
Q17	Network	818700050	100	CA3081
Q18	NPN	818203904		2N3904
Q19	NPN	818203904		2N3904
Q20	Fet N Chan	818700009	55	TIS-75
	Resistors			
	All resistors, unless otherwise designated, are 1/4W, 5% Comp. * 1/8W, 1%, Met Film ** 1 W, 5%, WW (Flameproof)			
R1	100K	817007104		RC07
R2	100K	817007104		RC07
R3	68K	817007683		RC07
R4	68K	817007683		RC07
R5	68K	817007683		RC07
R6	68K	817007683		RC07
R7	68K	817007683		RC07
R8	68K	817007683		RC07
R9	68K	817007683		RC07
R10	100K	817007104		RC07
R11	100K	817007104		RC07
R12	12K	817007123		RC07
R13	1.47K*	817211147		RN60D
R14	68K	817007683		RC07
R15	15K	817007153		RC07
R16	15K	817007153		RC07
R17	68K	817007683		RC07
R18	100K	817007104		RC07
R19	10Ω**	817003100	57	BW20F-10Ω
R20	33K, HV	817000031	3	RC07
R21	100K	817007104		RC07
R22	15K	817007153		RC07
R23	15K	817007153		RC07
R24	15K	817007153		RC07
R25	68K	817007683		RC07
R26	220Ω	817007221		RC07
R27	4.7K	817007472		RC07
R28	1.47K*	817211147		RN60D
R29	1M	817007105		RC07
R30	1M	817007105		RC07
R31	68K x 7 SIP	817400012	18	750-81-R68K
R34	15K x 7 SIP	817400011	18	750-81-R15K
R35	68K x 7 SIP	817400012	18	750-81-R68K
R36	15K x 7 SIP	817400011	18	750-81-R15K
R37	33K, HV	817000031		RC07
R38	33K, HV	817000031		RC07
R39	33K, HV	817000031		RC07
R40	33K, HV	817000031		RC07

REFERENCE DESIGNATION	DESCRIPTION	ITHACO PART NUMBER	MANUFACTURER CODE	MANUFACTURER PART NUMBER
	Resistors (con't)			
R41	33K, HV	817000031		RC07
R42	33K, HV	817000031		RC07
R43	33K, HV	817000031		RC07
R44	33K, HV	817000031		RC07
R45	33K, HV	817000031		RC07
R46	33K, HV	817000031		RC07
R47	33K, HV	817000031		RC07
R48	33K, HV	817000031		RC07
R49	33K, HV	817000031		RC07
R50	33K, HV	817000031		RC07
R51	33K, HV	817000031		RC07
	Int. Circuits			
U1	CDI3004	B88626-P1		CDI3004
U2	CDI3003	B88627-P1		CDI3003
U3	MC14028BCP	816374028		MC14028BCP
U4	MC14049BCP	816374049		MC14049BCP

CODE LIST OF MANUFACTURERS

1	Aerovox
2	Alco Electronic Prod
3	Allen Bradley
4	Amphenol Connector
5	Analog Devices
6	Belden
7	Bourns
8	Buckeye Stamping
9	Bussman Mfg
10	Cambion
11	Cannon, ITT
12	Centralab
13	Cinch Mfg
14	C & K Components
15	Continental–Wirt Elec
16	Corcom
17	Cornell Dubilier Elec
18	CTS
19	Dage Electric
20	Delevan Electronics
21	Dresser Systems
22	Electrocube
23	Electro Motive Mfg
24	Electronics Applications
25	Erie Technological Products
26	Fairchield Semiconductor
27	Federal Screw Prod
28	General Electric
29	Helipot
30	Heyman Mfg
31	ITHACO
32	E F Johnson
33	Litronix
34	Marco–Oak Industries
35	Motorola Semiconductor Prod
36	National Semiconductor
37	Ohmite Mfg
38	Paktron
39	Panduit
40	Pomona Electronics
41	Product Components
42	Pyrofilm
43	RCL Electronics
44	Rembrandt
45	Rogan
46	Schauer Mfg
47	H H Smith
48	Sprague Electric
49	Spectrol Electronics
50	Stancor
51	D M Steward Mfg
52	Switchcraft
53	Teledyne Semiconductor
54	Teledyne Western Wire and Cable
55	Texas Instruments
56	Thermalloy
57	TRW
58	United Transformer
59	Useco
60	Vactec
61	Winchester Electronic
62	Vishay
63	ACI
64	IRC
65	EAL
66	AMP
67	Clarostat Mfg
68	Gould Inc
69	Littlefuse Inc
70	General Illumination
71	Signetrics
72	Semiconductor Cir
73	Statek
74	Bendix
75	Burndy
76	American Handle Sales
77	Varo Semiconductor
78	Dialco
79	Elmenco
80	Amp Incorporated
81	Berg
82	Comp Corp
83	Hewlett–Packard
84	Beckman Helipot
85	Raytheon
86	Intersil
87	A H & H
88	ADC Products
89	Scanbe
90	Drake
91	Victoreen
92	Frost
93	Sigma
94	Becon
95	Microswitch
96	Wavetek
97	Electronic Concepts
98	Amelco
99	Mepco
100	RCA
101	Circuit Asm Corp
102	Monsanto
103	Ainsley
104	Keystone Carbon
105	JFD
106	EAC
107	Douglas Randall
108	Siliconix

TABLE 6.3 CODE LIST OF MANUFACTURERS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3
4
5
A
B
C
D
E
F
G
H
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(A1-S1)
(E3)
(UNDER R1)
(A1-J1)
(A1-J2)
(A1-DS2)
(A1-J3)
(A2-W2S5)
(A2-W2)
(A3)
(P1)
(P2)
(P3)
(P5)
(P6)
P4
A3-J1
K2
C4
C62
C77
R23
R24
R68
R144
R182
TP1
TP2
TP3
TP4
TP5
TP6
TP7
TP8
TP10
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(BATTERY PACK)
Q1
Q3

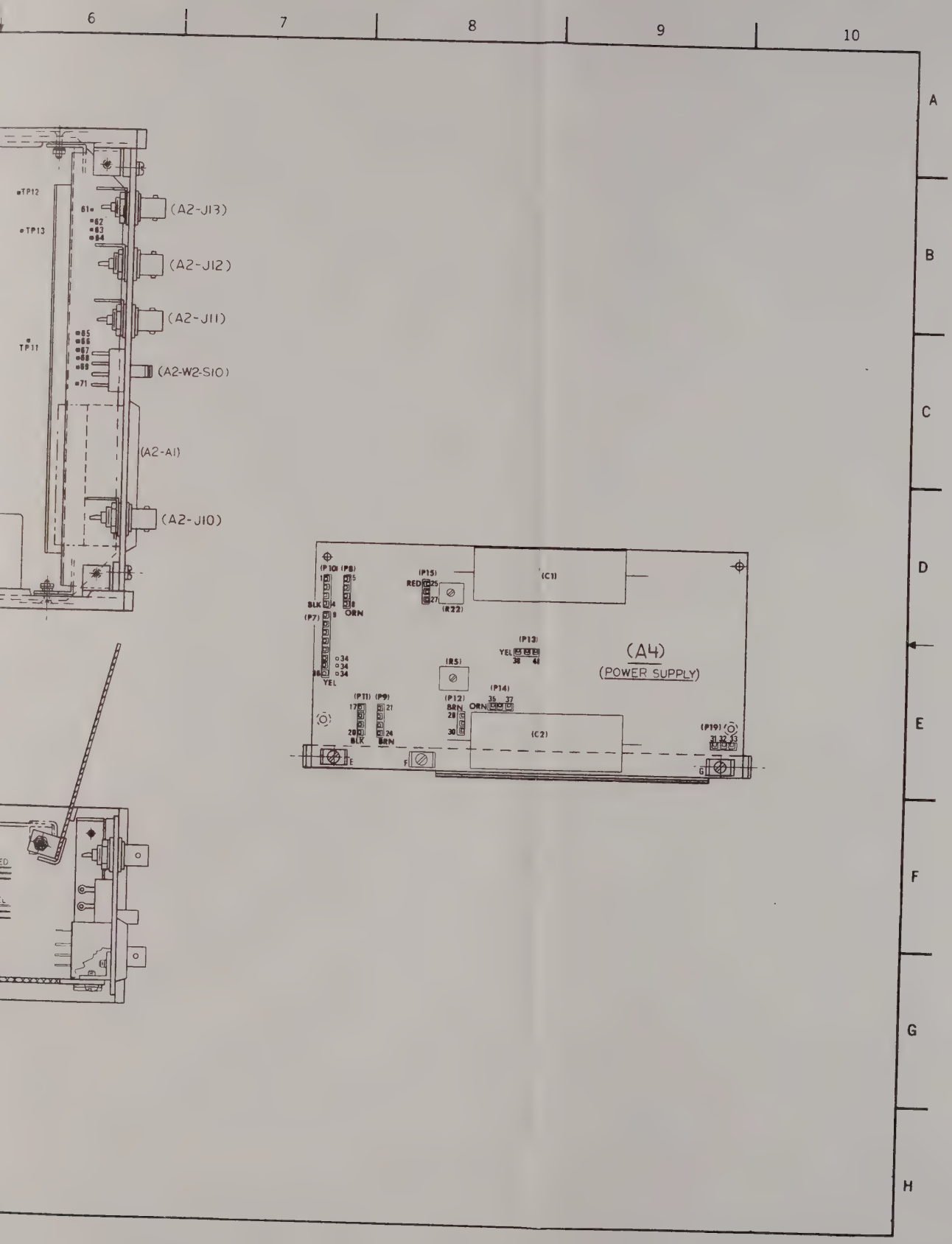
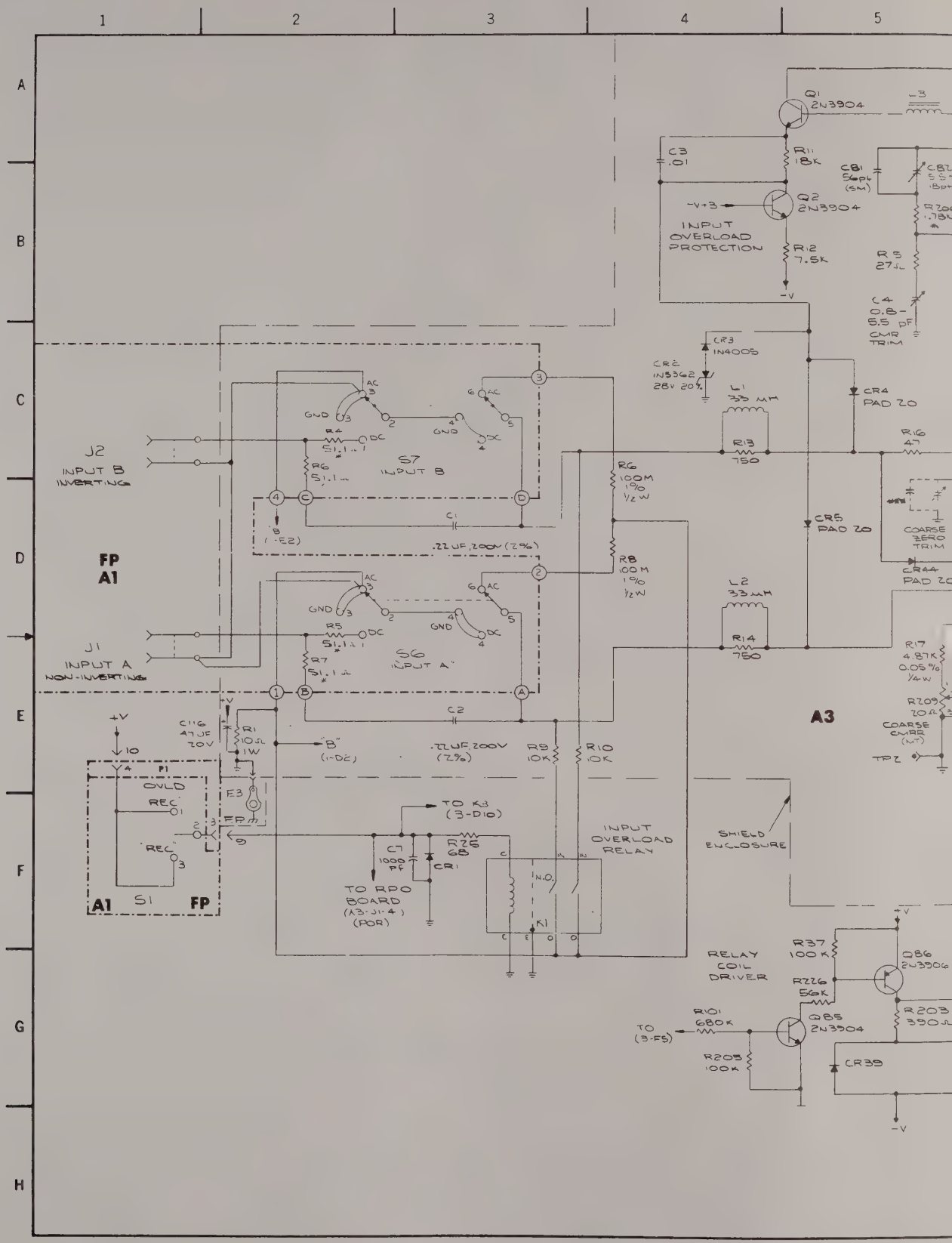


FIGURE 9.1
MAJOR ASSEMBLY
1201 PREAMPLIFIER


1
2
3
4
5
A
B
C
D
E
F
G
H
Q1 2N3904
C3 .01
R11 18K
C81 56pf (SM)
Q2 2N3904
-V+3
INPUT OVERLOAD PROTECTION
R12 7.5K
-V
R3 27Ω
C4 0.8-5.5 pF CMR TRIM
CR3 IN4005
CR2 IN5362 28V 20%
L1 33 MH
CR4 PAD 20
R13 750
R16 4.7
J2 INPUT B INVERTING
S7 INPUT B
R4 51.1Ω
R6 51.1Ω
C1 .22 UF, 200V (2%)
FP A1
J1 INPUT A NON-INVERTING
S6 INPUT A
R5 51.1Ω
R7 51.1Ω
R6 100M 1% ½W
R8 100M 1% ½W
CR5 PAD 20
COARSE ZERO TRIM
CR44 PAD 20
L2 33 MH
R14 750
R17 4.87K 0.05% ¼W
R209 20Ω
COARSE CMRR (MT)
TP2
A3
+V
C116 47 UF 20V
R1 10Ω 1W
"B" (1-DC)
C2 .22UF 200V (2%)
R9 10K
R10 10K
P1
OVLD
REC
FP
S1
A1 FP
TO K3 (3-D10)
INPUT OVERLOAD RELAY
SHIELD ENCLOSURE
C7 1000 pF
R25 68
CR1
TO RPO BOARD (A3-J1-4) (POR)
N.O.
K1
RELAY COIL DRIVER
R37 100K
Q86 2N3906
R226 56K
R101 680K
TO (3-F5)
Q85 2N3904
R203 390Ω
R203 100K
CR39
-V

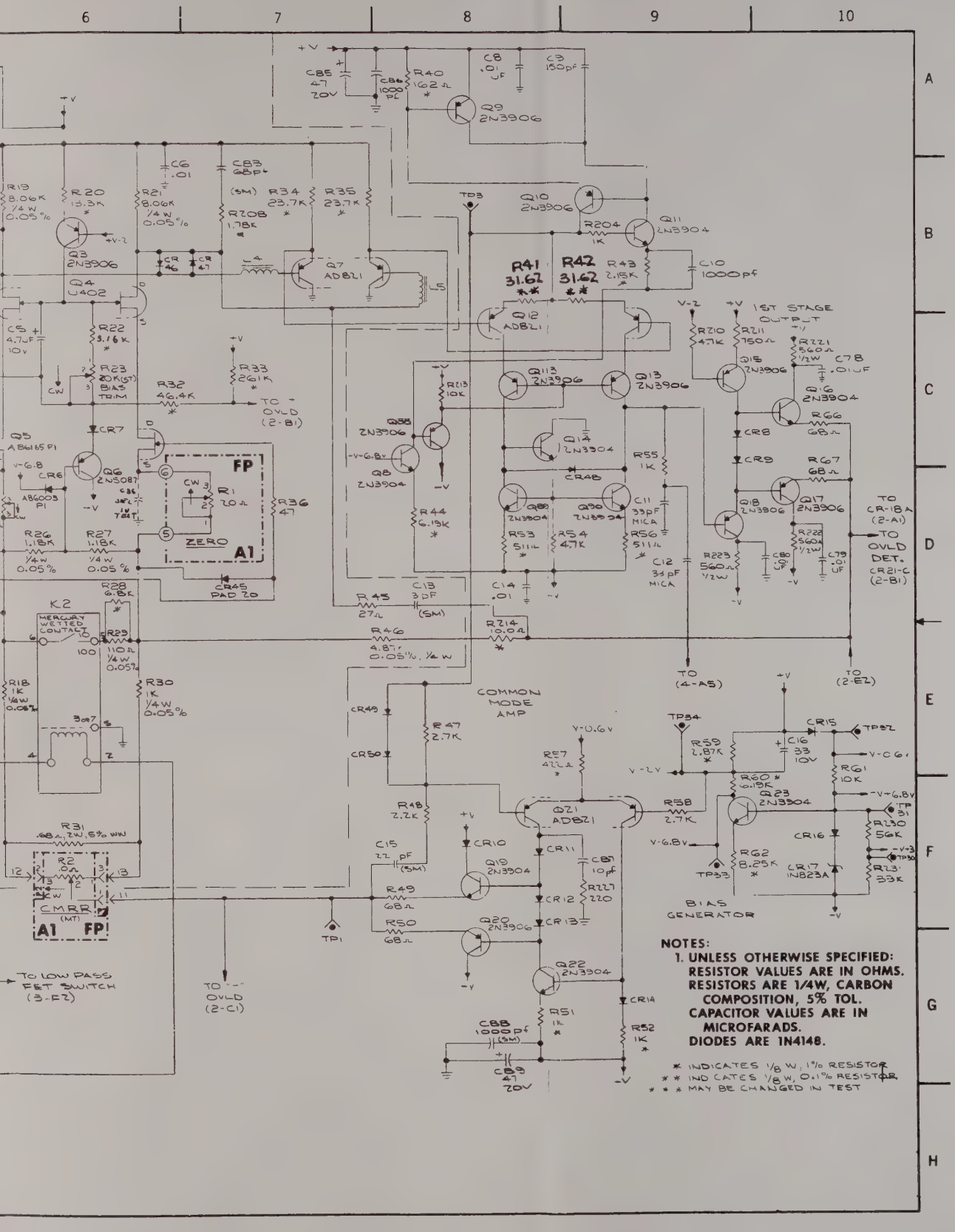
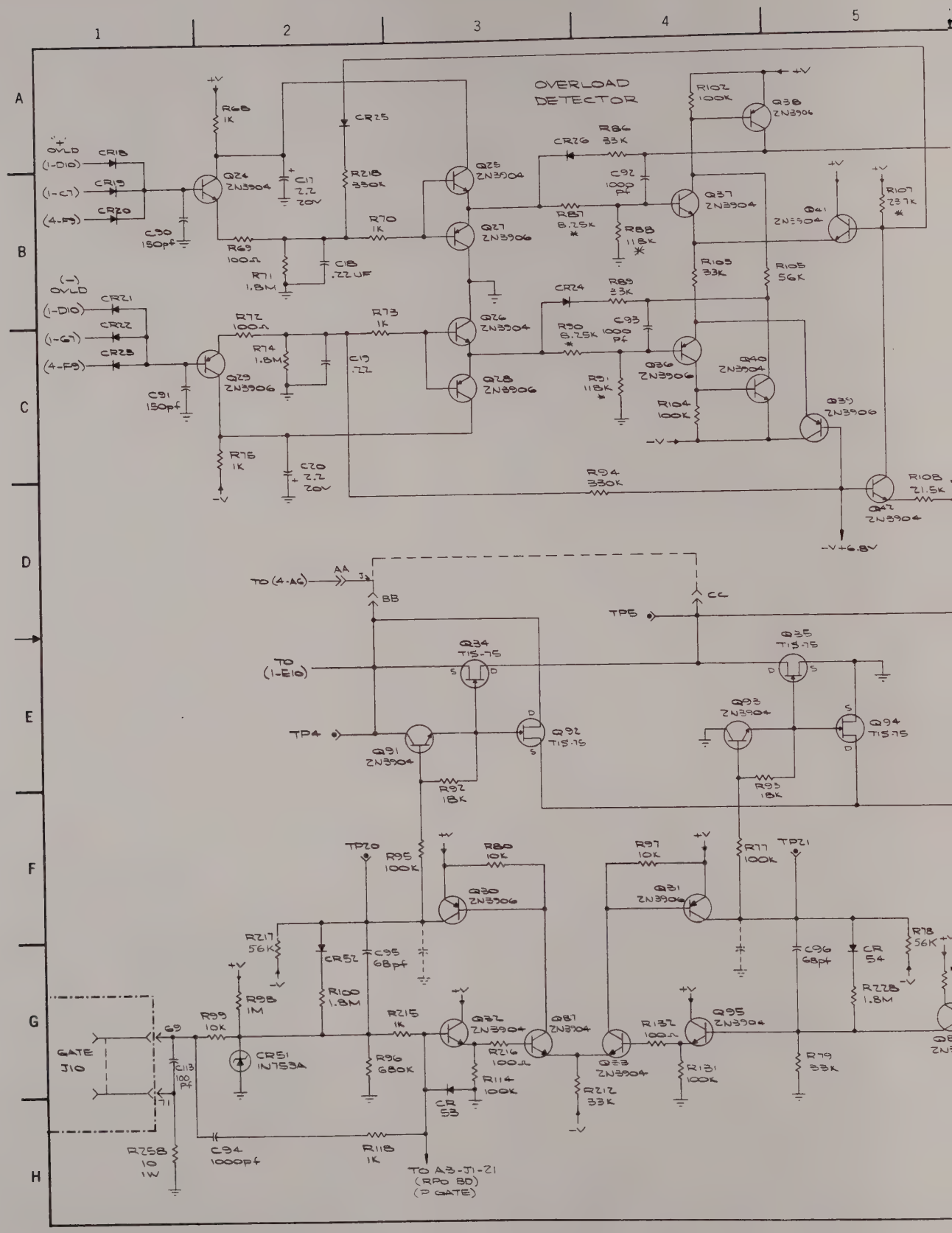
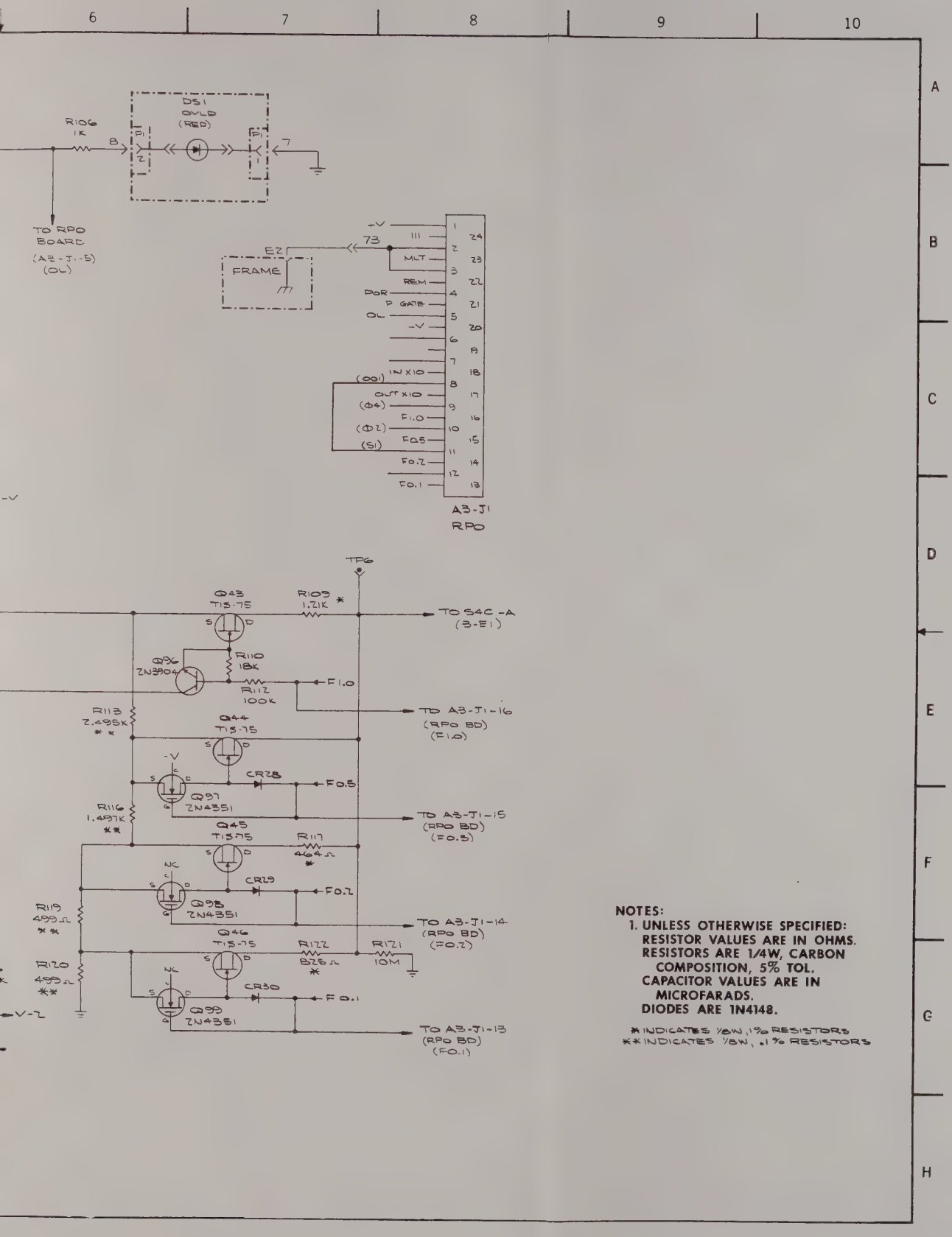


FIGURE 9.2
SCHEMATIC – INPUT CIRCUIT
1201 PREAMPLIFIER


OVERLOAD DETECTOR
(+) OVLD
(1-D10)
(1-C7)
(4-F9)
CR18
CR19
CR20
(-) OVLD
CR21
CR22
CR23
Q24 2N3904
Q25 2N3904
Q26 2N3904
Q27 2N3906
Q28 2N3906
Q29 2N3906
Q36 2N3906
Q37 2N3904
Q38 2N3904
Q39 2N3906
Q40 2N3904
Q41 2N3904
Q42 2N3904
R68 1K
R69 100Ω
R70 1K
R71 1.8M
R73 1K
R74 1.8M
R75 1K
R86 33K
R87 8.75K *
R88 118K *
R89 33K
R90 8.75K *
R91 118K *
R94 330K
R102 100K
R103 33K
R104 100K
R105 56K
R107 23.7K *
R108 21.5K
C17 2.2 20V
C18 .22 UF
C19 .22
C20 2.2 20V
C30 150pf
C91 150pf
C92 1000 pf
C93 1000 pf
CR25
CR26
CR24
-V+6.8V
TO (4-A6)
AA
BB
CC
TP5
TO (1-E10)
TP4
Q34 TIS-75
Q35 TIS-75
Q91 2N3904
Q92 TIS-75
Q93 2N3904
Q94 TIS-75
R92 18K
R93 18K
TP20
TP21
R95 100K
R80 10K
R97 10K
R77 100K
Q30 2N3906
Q31 2N3906
R217 56K
CR52
C95 68pf
C96 68pf
CR 54
R78 56K
R228 1.8M
R98 1M
R100 1.8M
R99 10K
R215 1K
Q32 2N3904
Q87 2N3904
Q33 2N3904
Q95 2N3904
R132 100Ω
R216 100Ω
R114 100K
R212 33K
R131 100K
R79 33K
CR51 IN753A
R96 680K
CR 53
G9
GATE J10
C113 100 pf
J1
R258 10 1W
C94 1000pf
R118 1K
TO A3-J1-21 (RPO BD) (P GATE)

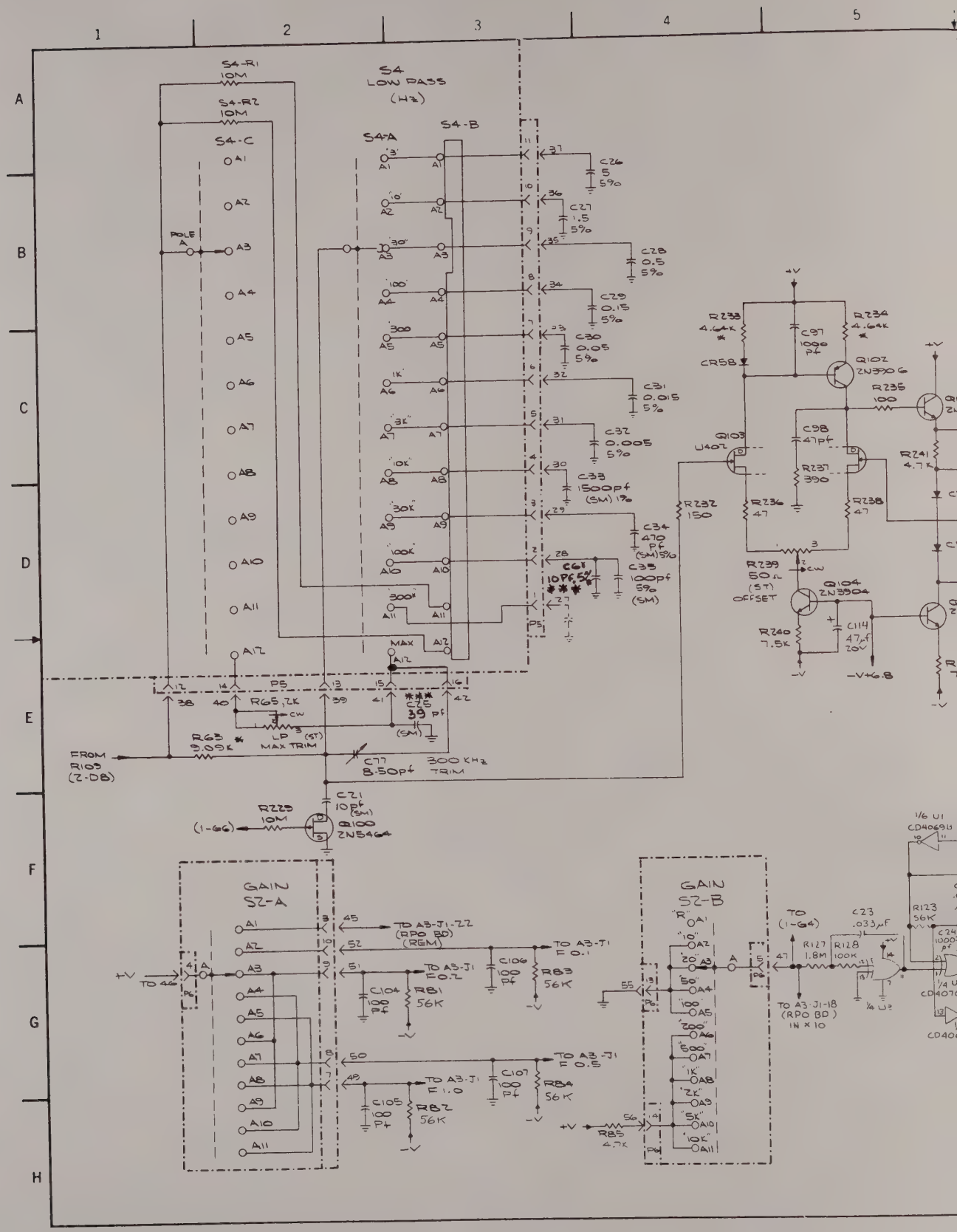


NOTES:

1. **UNLESS OTHERWISE SPECIFIED:**
   RESISTOR VALUES ARE IN OHMS.
   RESISTORS ARE 1/4W, CARBON COMPOSITION, 5% TOL.
   CAPACITOR VALUES ARE IN MICROFARADS.
   DIODES ARE 1N4148.

* INDICATES 1/8W, 1% RESISTORS
** INDICATES 1/8W, .1% RESISTORS

FIGURE 9.3
SCHEMATIC – OVERLOAD DETECTOR, GATE CIRCUIT
1201 PREAMPLIFIER



ITHACO DWG D42062, SH 3, REV F, 3/82

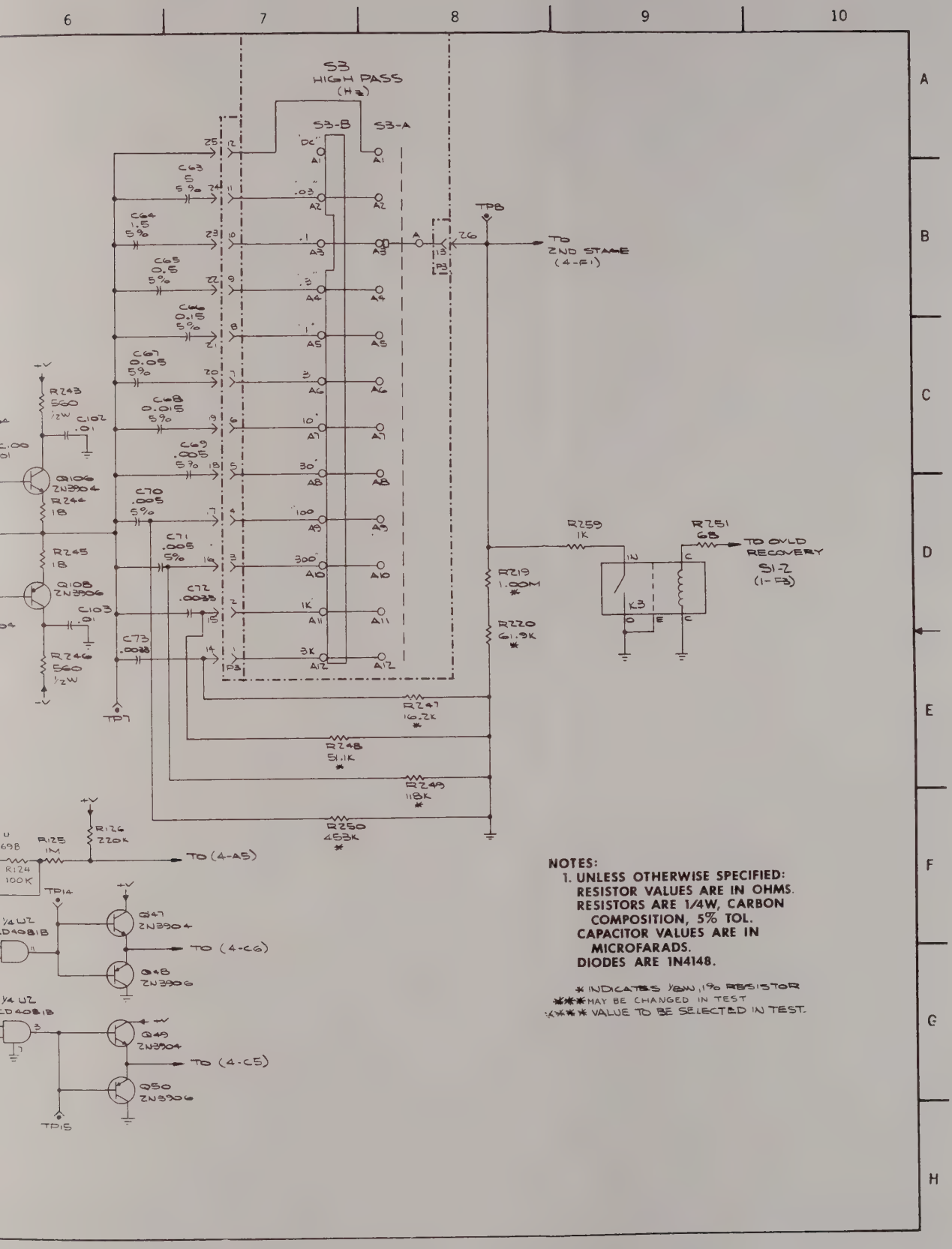
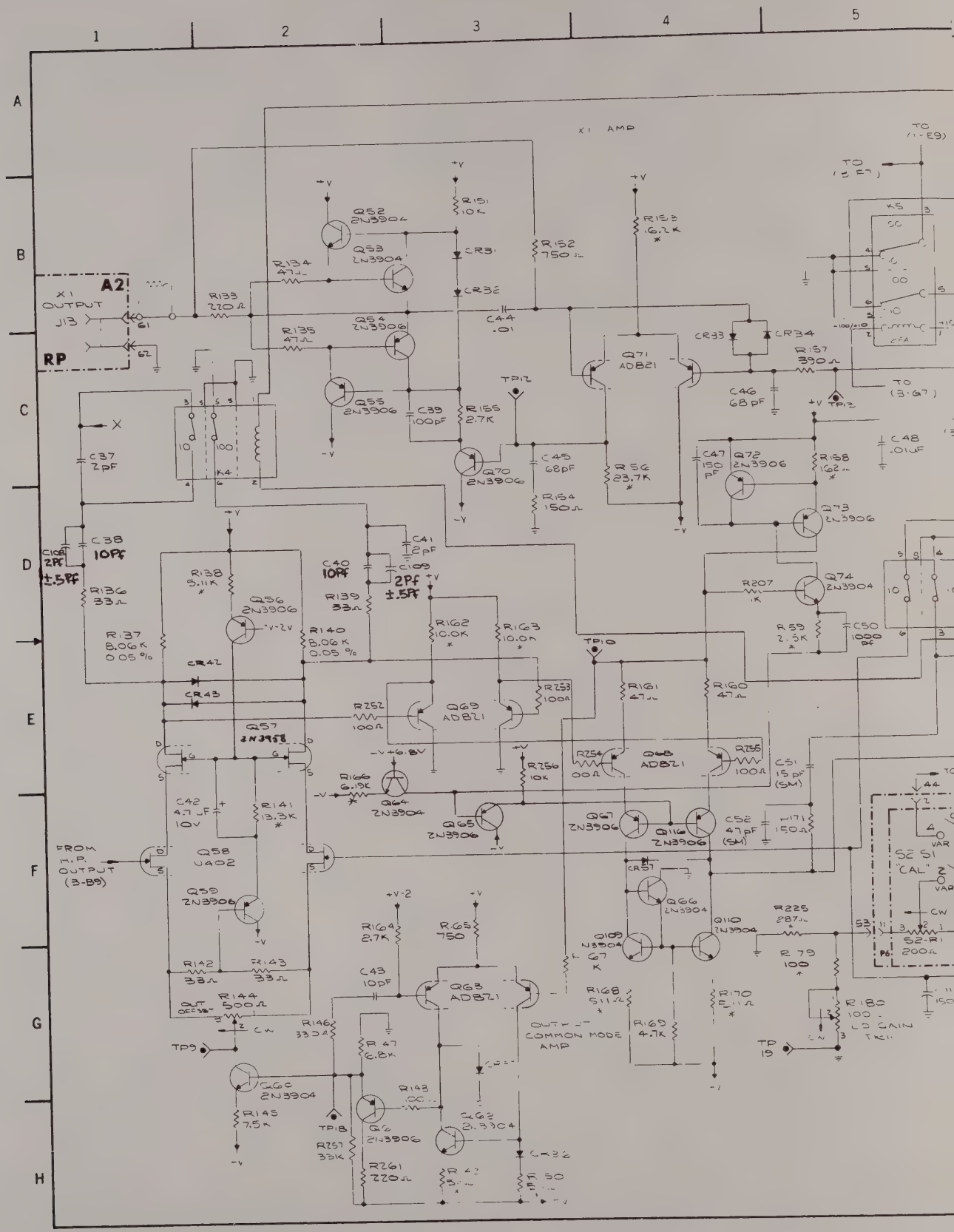


FIGURE 9.4
SCHEMATIC – HP AND LP FILTERS
1201 PREAMPLIFIER


X1 AMP
A2
X1 OUTPUT
J13
RP
TO (1-E9)
TO (1-E7)
TO (3-G7)
FROM M.P. OUTPUT (3-B9)
OUT COMMON MODE AMP
TP9
TP10
TP12
TP18
TP19
S2 S1 "CAL"
S2-R1 200Ω
LO GAIN TRIM
R180 100
R79 100
R225 287Ω
R59 2.5K
R57 1.67K
R56 23.7K
R37 8.06K 0.05%
R140 8.06K 0.05%
R144 500Ω
R145 7.5K
R146 330Ω
R147 .01
R148 .01
R149 .01
R150 .01
R151 10K
R152 750Ω
R154 150Ω
R155 2.7K
R157 390Ω
R158 162Ω
R161 47Ω
R162 10.0K
R163 10.0K
R164 2.7K
R165 750
R166 6.19K
R168 511Ω
R169 4.7K
R170 5.11Ω
R207 1K
R252 100Ω
R253 100Ω
R254 100Ω
R255 100Ω
R256 10K
R257 33K
R261 220Ω
C37 2pF
C38 10pF
C39 100pF
C40 10pF
C41 2pF
C42 4.7μF 10V
C43 10pF
C44 .01
C45 68pF
C46 68pF
C47 150pF
C48 .01μF
C50 1000pF
C51 15pF (SM)
C52 47pF (SM)
C63 8.33C4
Q52 2N3904
Q53 2N3904
Q54 2N3906
Q55 2N3906
Q56 2N3906
Q57 2N3958
Q58 U402
Q59 2N3906
Q60 2N3904
Q61 2N3904
Q62 2N3906
Q63 AD821
Q64 2N3904
Q65 2N3906
Q66 2N3904
Q67 2N3906
Q68 AD821
Q69 AD821
Q70 2N3906
Q71 AD821
Q72 2N3906
Q73 2N3906
Q74 2N3904
Q109 2N3904
Q110 2N3904
Q116 2N3906
CR31
CR32
CR33
CR34
CR42
CR43
CR57
CR58
K4
K5

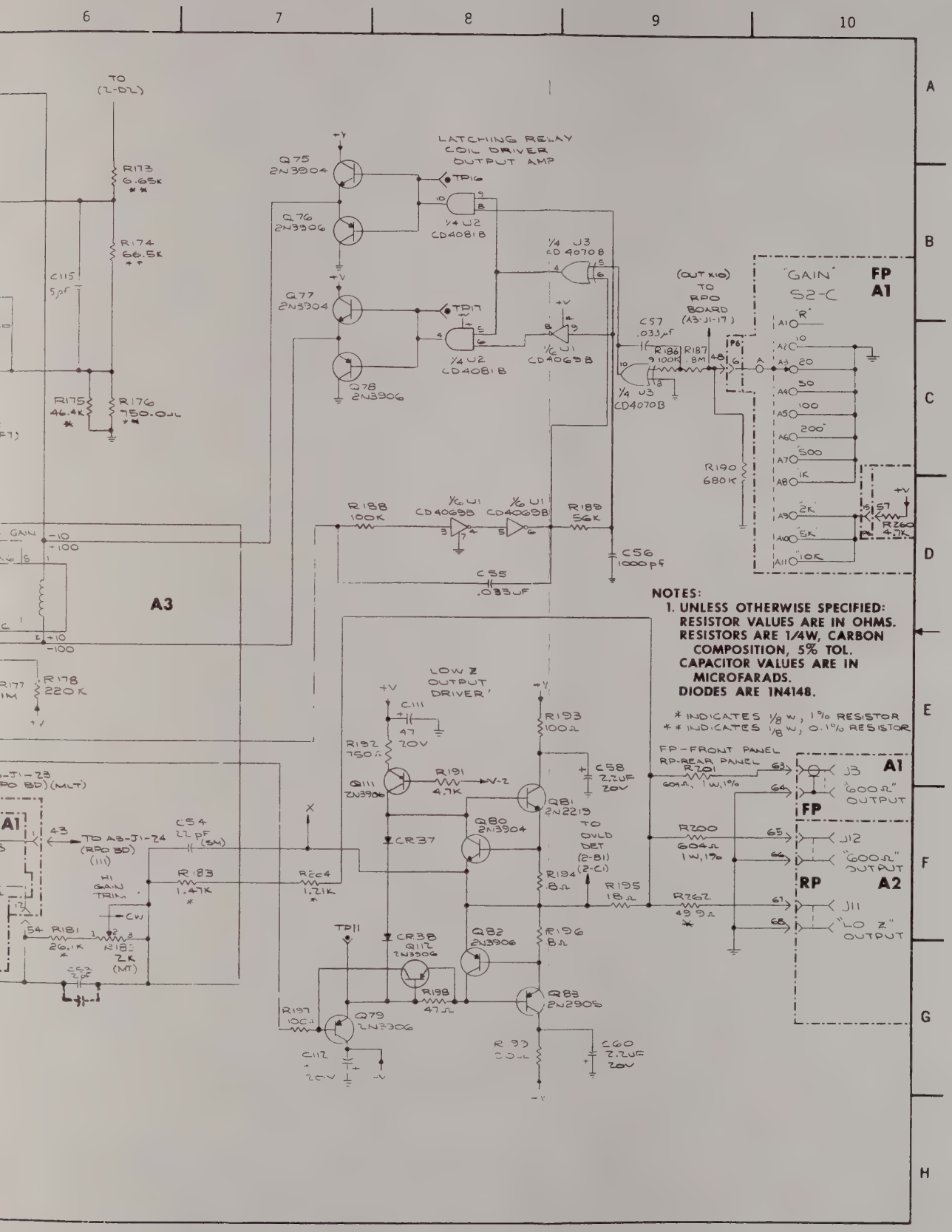
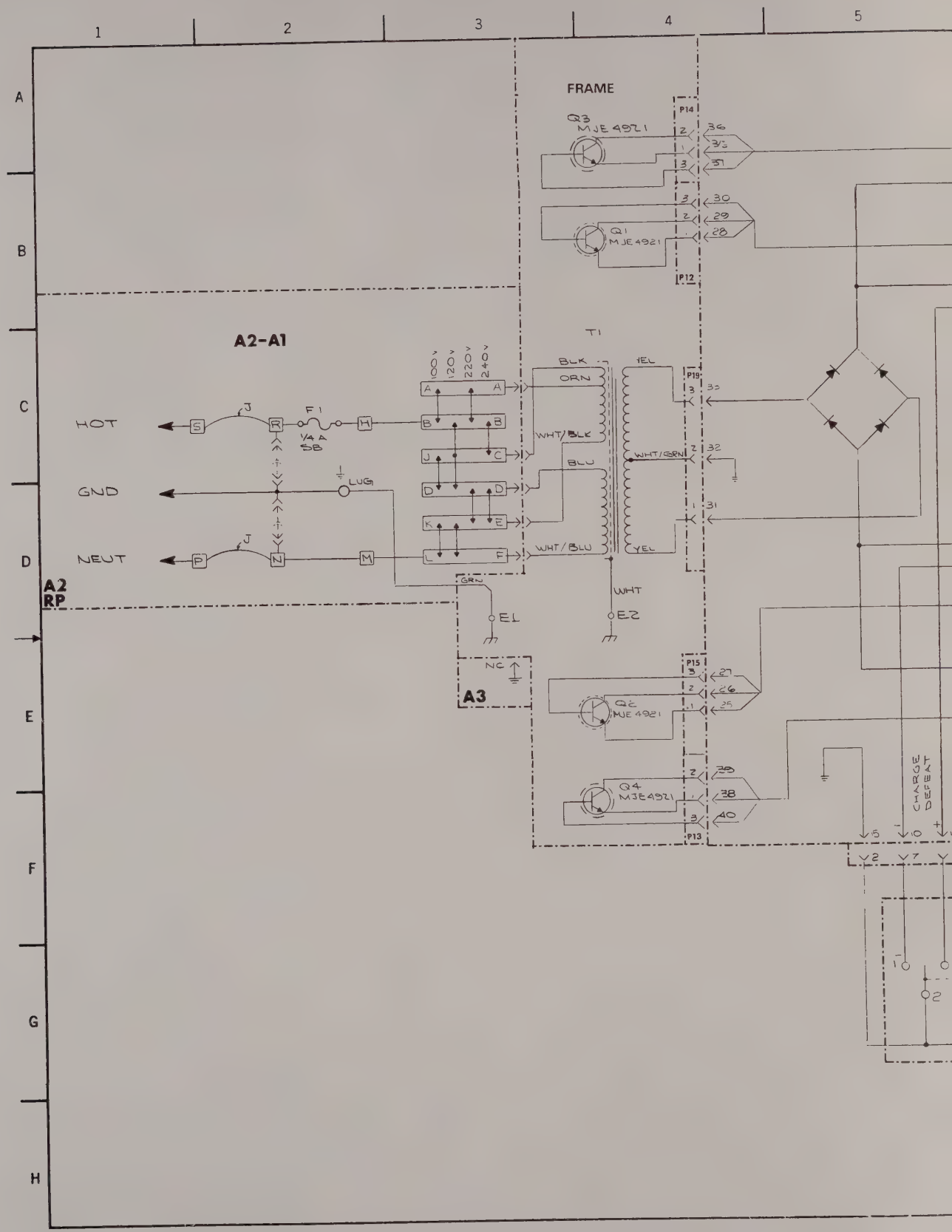

LATCHING RELAY COIL DRIVER OUTPUT AMP
LOW Z OUTPUT DRIVER
A3
A1
FP
RP
A2
NOTES:
1. UNLESS OTHERWISE SPECIFIED: RESISTOR VALUES ARE IN OHMS. RESISTORS ARE 1/4W, CARBON COMPOSITION, 5% TOL. CAPACITOR VALUES ARE IN MICROFARADS. DIODES ARE 1N4148.
* INDICATES 1/8 W, 1% RESISTOR
** INDICATES 1/8 W, 0.1% RESISTOR
FP - FRONT PANEL
RP - REAR PANEL
"600Ω" OUTPUT
"LO Z" OUTPUT

FIGURE 9.5
SCHEMATIC – OUTPUT AND XI AMP
1201 PREAMPLIFIER


1
2
3
4
5
A
B
C
D
E
F
G
H
FRAME
Q3
MJE 4921
P14
36
35
37
3
2
1
30
29
28
Q1
MJE 4921
P12
A2-A1
T1
100 v
120 v
220 v
240 v
BLK
ORN
YEL
WHT/BLK
WHT/GRN
BLU
WHT/BLU
YEL
P19
33
32
31
HOT
GND
NEUT
J
F1
1/4 A
SB
S
R
H
P
N
M
LUG
A
B
C
D
E
F
K
L
GRN
WHT
E1
E2
A2
RP
NC
A3
P15
27
26
25
Q2
MJE 4921
Q4
MJE 4921
39
38
40
P13
CHARGE
DEFEAT
5
10
12
7
11
2

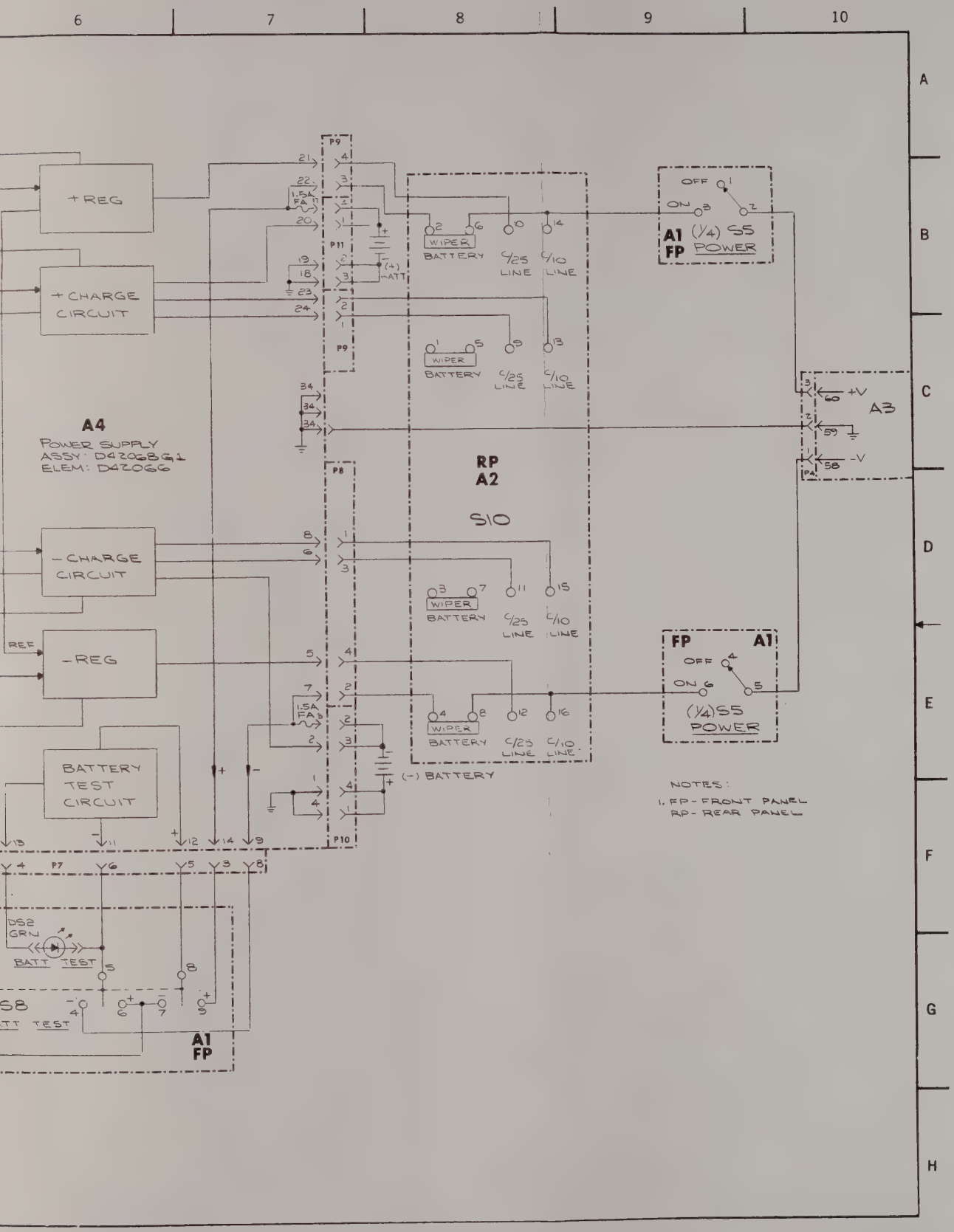
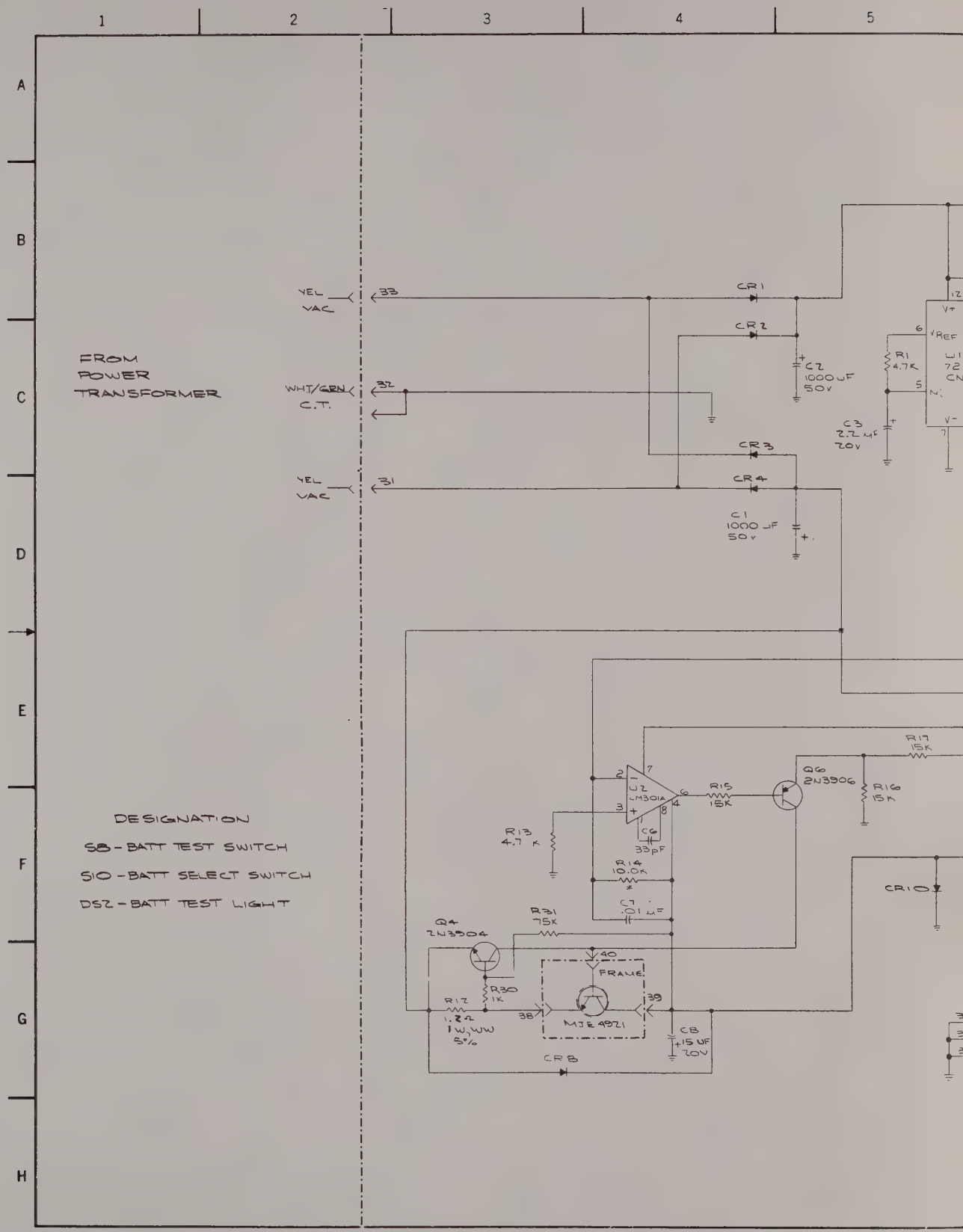


FIGURE 9.6
SCHEMATIC – POWER SUPPLY
1201 PREAMPLIFIER


1
2
3
4
5
A
B
C
D
E
F
G
H
FROM POWER TRANSFORMER
YEL VAC
WHT/GRN C.T.
YEL VAC
33
32
31
CR1
CR2
CR3
CR4
C2 1000 uF 50V
C1 1000 uF 50V
C3 2.2 uF 20V
R1 4.7K
VREF
U1 723 CN
U2 LM301A
R13 4.7 K
R14 10.0K
C6 33pF
C7 .01 uF
R15 15K
Q6 2N3906
R16 15K
R17 15K
CR10
Q4 2N3904
R31 15K
R30 1K
R17 1.2Ω 1W, WW 5%
40
FRAME
39
38
MJE 4921
C8 +15 UF 20V
CR8
DESIGNATION
SB - BATT TEST SWITCH
S10 - BATT SELECT SWITCH
DS2 - BATT TEST LIGHT

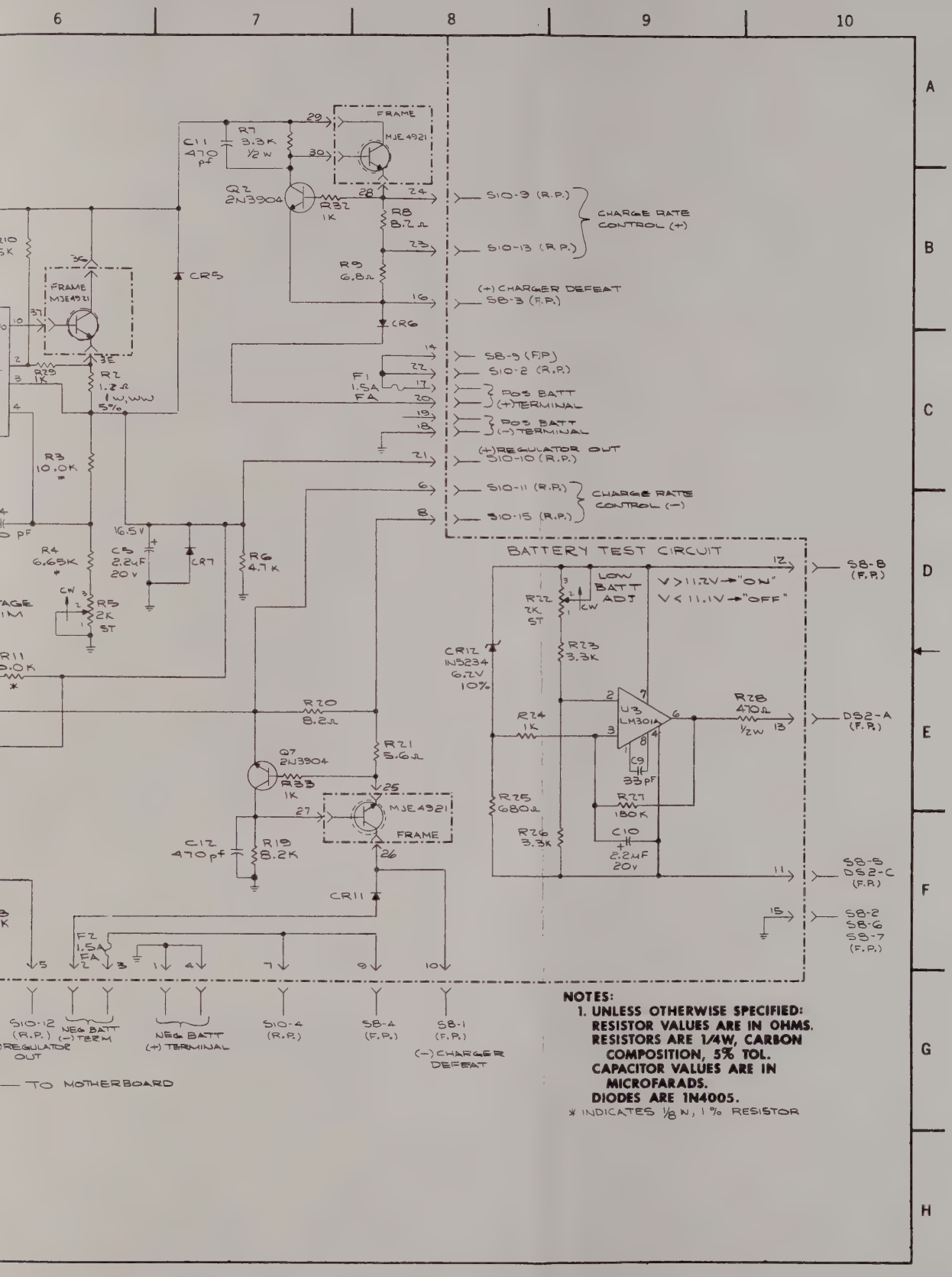
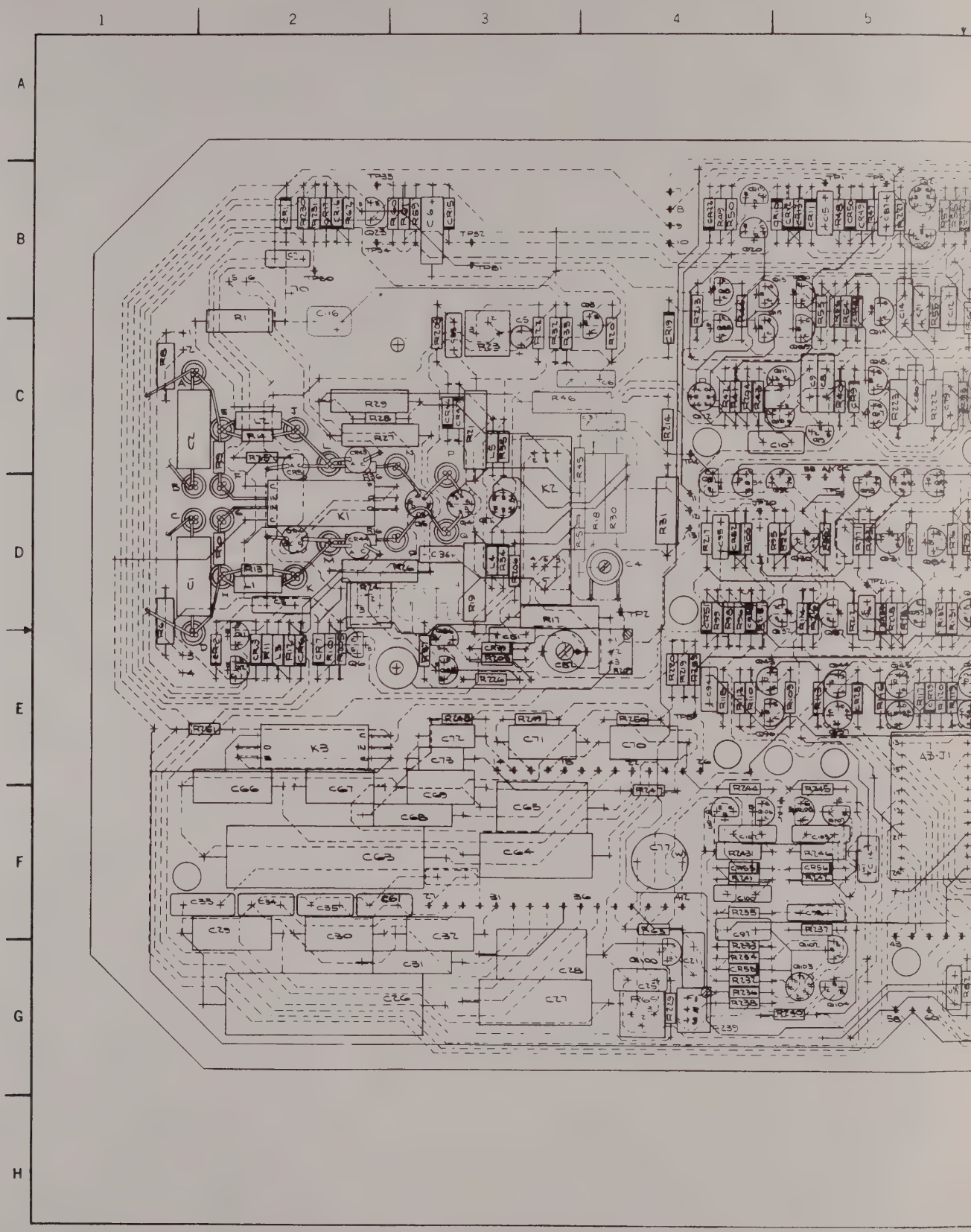


FIGURE 9.7
SCHEMATIC – POWER SUPPLY CARD
1201 PREAMPLIFIER



ITHACO DWG D42071, SH 1, REV J, 3/82

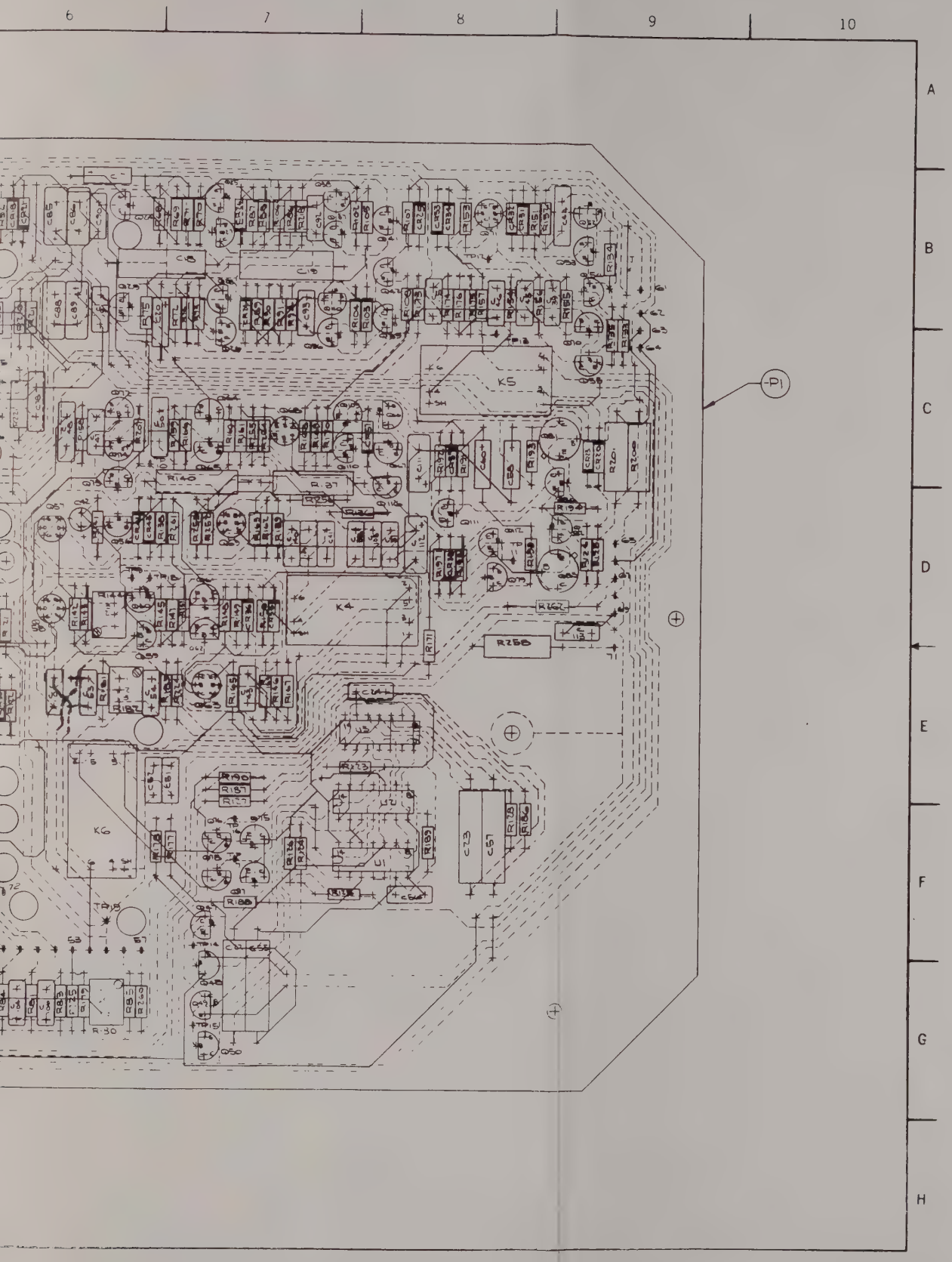


FIGURE 9.8
ASSEMBLY – MOTHERBOARD (A3)
1201 PREAMPLIFIER

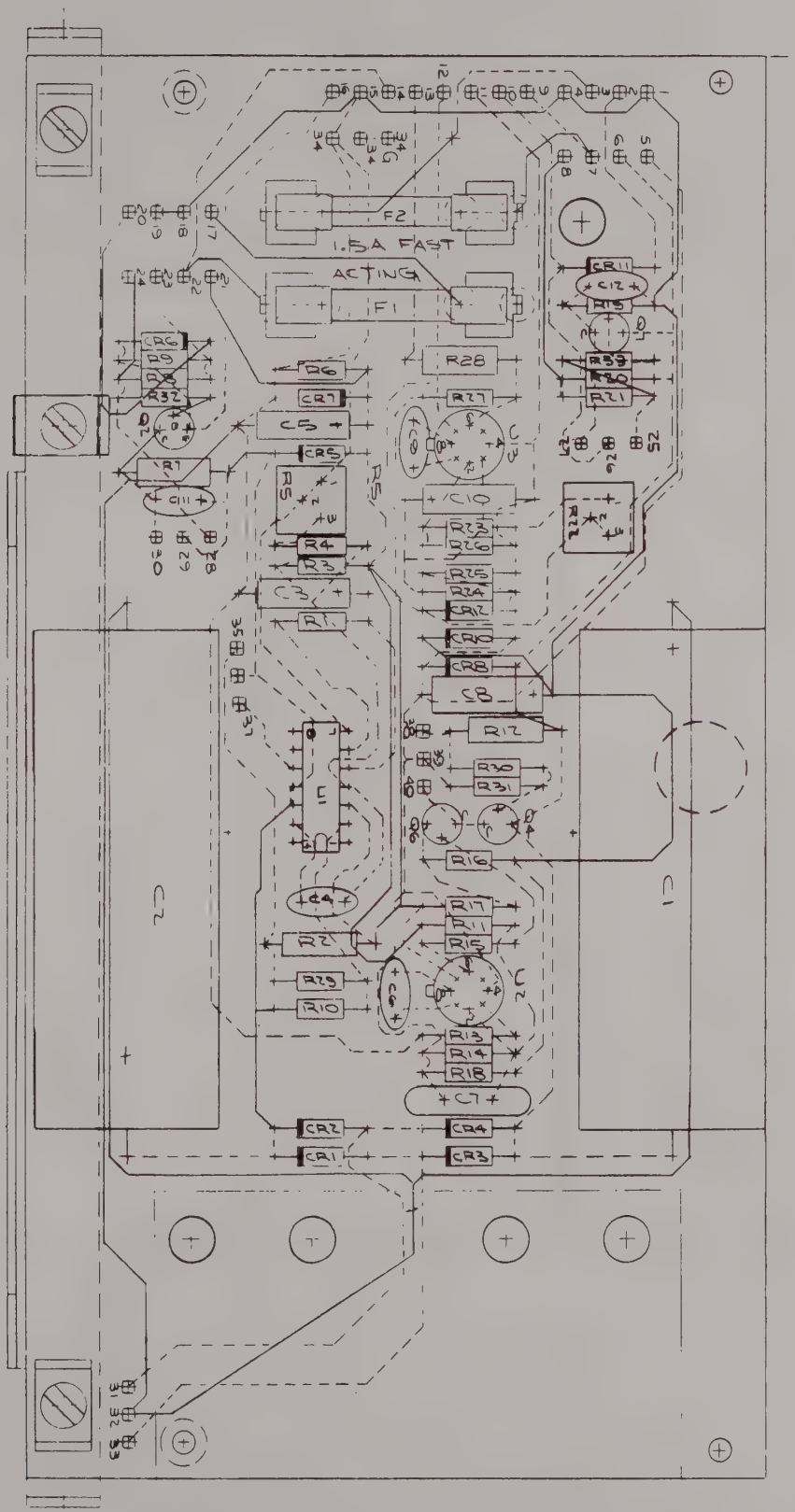
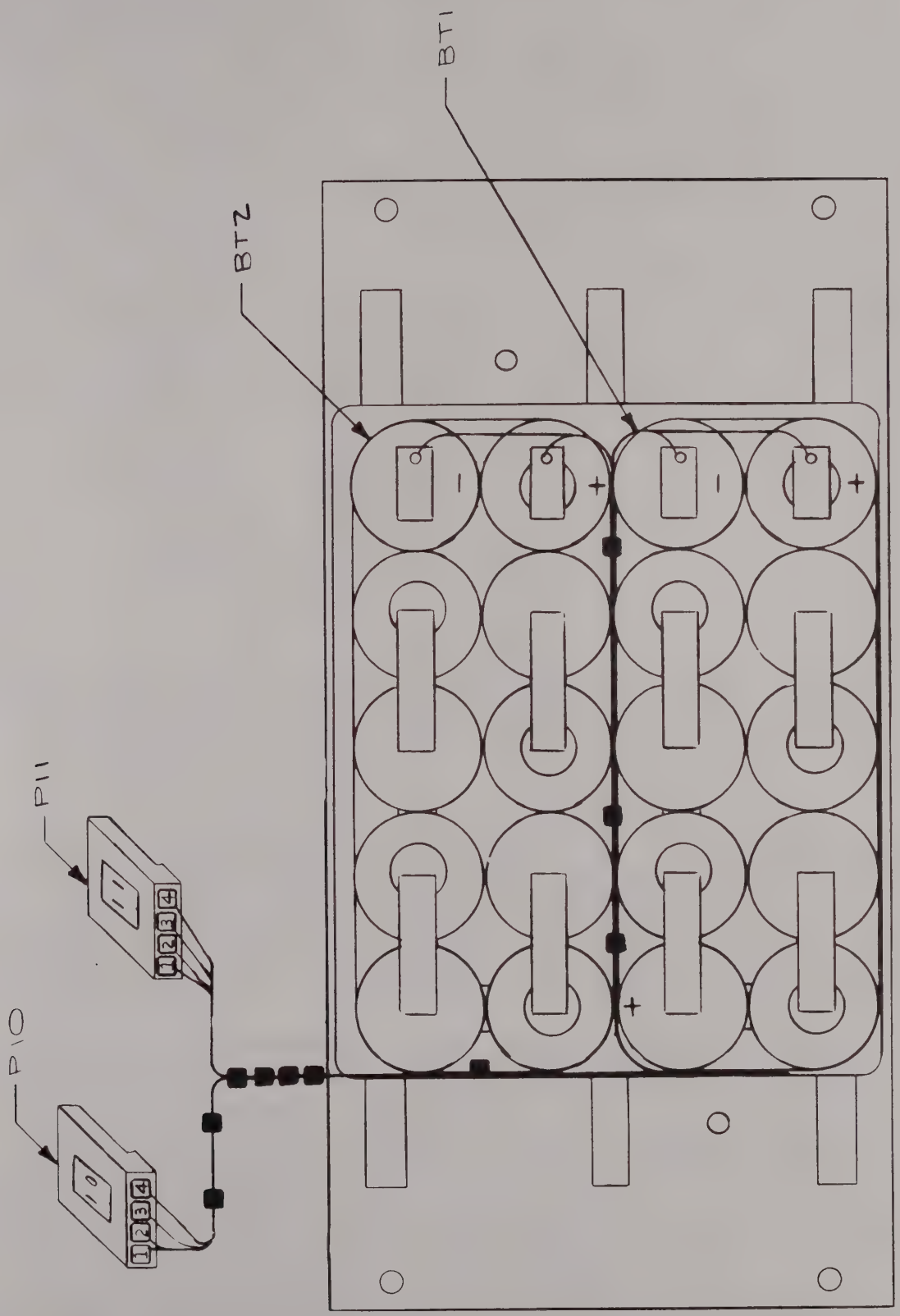


FIGURE 9.9 ASSEMBLY – POWER SUPPLY CARD 1201 PREAMPLIFIER

ITHACO DWG D42068, SH 1, REV G, 11/80



ITHACO DWG C32258, SH 1, REV B, 2/81 FIGURE 9.10 ASSEMBLY – BATTERY PACK 1201 PREAMPLIFIER

INSTALLATION INSTRUCTIONS

REMOTE PROGRAMMABLE OPTION 06 MODEL 1201

LIST OF ITEMS TO BE ADDED TO THE UNIT

DESCRIPTION

ITEM	PART NO.	DESCRIPTION	QTY
A101	D42164 G1	ASM, CARD, R.P. OPTION	1
S4E,D	B22745 G1	ASM, SW WAFER, LOW PASS R.P.O	1
S3C,D	B22746 G1	ASM, SW WAFER, HIGH PASS R.P.O	1
W3	A88628 P6	CABLE, RIBBON 24 CONDUCTOR	1
P1	812122015	CONNECTOR, 36 PIN	1
1	812811408	SCR, PAN HD #4-40 X 1/4 LG	2
2	812806039	CABLE TIE, TWIST LOCK	5
3	A12391 G1	SHIELD ASM	2
4	812830010	#4-40 NUT, SMALL	8
5	812841414	#4 LOCK WASHER, SPLIT	8

INSTRUCTIONS

1. CAUTION: TO AVOID SHOCK, REMOVE POWER CORD BEFORE OPENING TOP COVER. ALSO, TO AVOID FIRE/BURN HAZARD, TAKE CARE NOT TO SHORT THE BATTERY OR ANY CONNECTIONS ON THE POWER SUPPLY CARD (A4)

2. TURN OFF THE F.P. POWER SWITCH, AND REMOVE TOP COVER.

3. REMOVE THE TWO FRONT SETS OF HARDWARE (ON EITHER SIDE OF THE RUBBER BUTTON) HOLDING THE POWER SUPPLY (A4) IN POSITION AND PIVOT THE POWER SUPPLY BACK TOWARD THE REAR PANEL.

4. REMOVE THE HARDWARE HOLDING THE BATTERY PACK IN POSITION AND LAY THE PACK ALONG SIDE THE AMPLIFIER UNIT WITH ALL WIRING INTACT.

5. FROM THE REAR PANEL REMOVE THE OPTION COVER PLATE (ITEM 10) AND RETURN IT TO STOCK. (RETAIN THE HARDWARE)

6. TAKING CARE TO AVOID EXISTING WIRING FROM OUTPUT COAX CONNECTORS, INSTALL ITEM A101 IN POSITION. SECURE A101 MOUNTING BRACKET INSIDE UNIT WITH ITEM 1. ALWAYS TIGHTEN REAR PANELS SCREWS FIRST.

7. CONNECT W3 (CABLE, RIBBON-24 CONDUCTOR) FROM A3-J1 TO A101-J2 AND P1 (CONNECTOR 36 PIN) TO A101-J1.

8. REMOVE ANY EXTRA NUTS IF PRESENT ON S3 (HIGH PASS) AND S4 (LOW PASS) LEAVING ONE NUT TO HOLD WAFERS. (HOLD FRONT NUT WHILE REMOVING OTHERS)

FIGURE 9.11 INSTALLATION INSTRUCTIONS – MODEL 1201-06 REMOTE PROGRAMMING OPTION – SHEET 1

ITHACO DWG A12347, SH 1, REV D, 10/80

INSTALLATION INSTRUCTIONS

REMOTE PROGRAMMABLE OPTION 06 MODEL 1201

INSTRUCTIONS (CONTINUED)

9. INSTALL SHIELDS (ITEM 3) ON S3, S4 WITH LIP ON BOTTOM POINTING TOWARD THE REAR. USE 1 NUT & LOCKWASHER ON EACH SCREW.

10. INSTALL S3C & S3D (B22746 G1) ON S3 HIGH PASS. ASSURE THAT ADDED WAFERS ARE ORIENTED SUCH THAT THE WIPER (YELLOW WIRE) IS IN THE "ONE O'CLOCK" POSITION WHEN VIEWED FROM THE REAR. REINSTALL NUTS.

11. INSTALL S4D & E (B22745 G1) ON S4 (LOW PASS) ASSURE THAT ADDED WAFERS ARE ORIENTED SUCH THAT THE WIPER (YELLOW WIRE) IS IN THE "ONE O'CLOCK" POSITION WHEN VIEWED FROM THE REAR. REINSTALL NUTS.

12. ROUTE THE CABLES FROM S3 AND S4 THROUGH WIRING POINTS C & H AND TIE WRAP (ITEM 2) WITH A2-W2. CONNECT P32 TO A101 PINS 1 THRU 10 AND CONNECT P33 TO A101 PINS 11 THRU 20 AS SHOWN ON SHEET 4.

13. REASSEMBLE AND TEST OPTION PER QTIP 1044. FOR FIELD INSTALLATION REFER TO APPROPRIATE SECTION IN THE MANUAL.

14. PERFORM HYPOT TEST (QTIP 9017) AND 1201 FINAL TEST QTIP 1044.

15. VERIFY THAT POWER SWITCH IS OFF AND BATTERY SWITCH IS IN C/10 POSITION FOR STORAGE OR SHIPPING. TAPE POWER SWITCH IN "OFF" POSITION FOR SHIPPING.

FIGURE 9.11 INSTALLATION INSTRUCTIONS – MODEL 1201-06 REMOTE PROGRAMMING OPTION – SHEET 2

TITLE

INSTALLATION INSTRUCTIONS
REMOTE PROGRAMMING OPTION 06, MODEL 1201

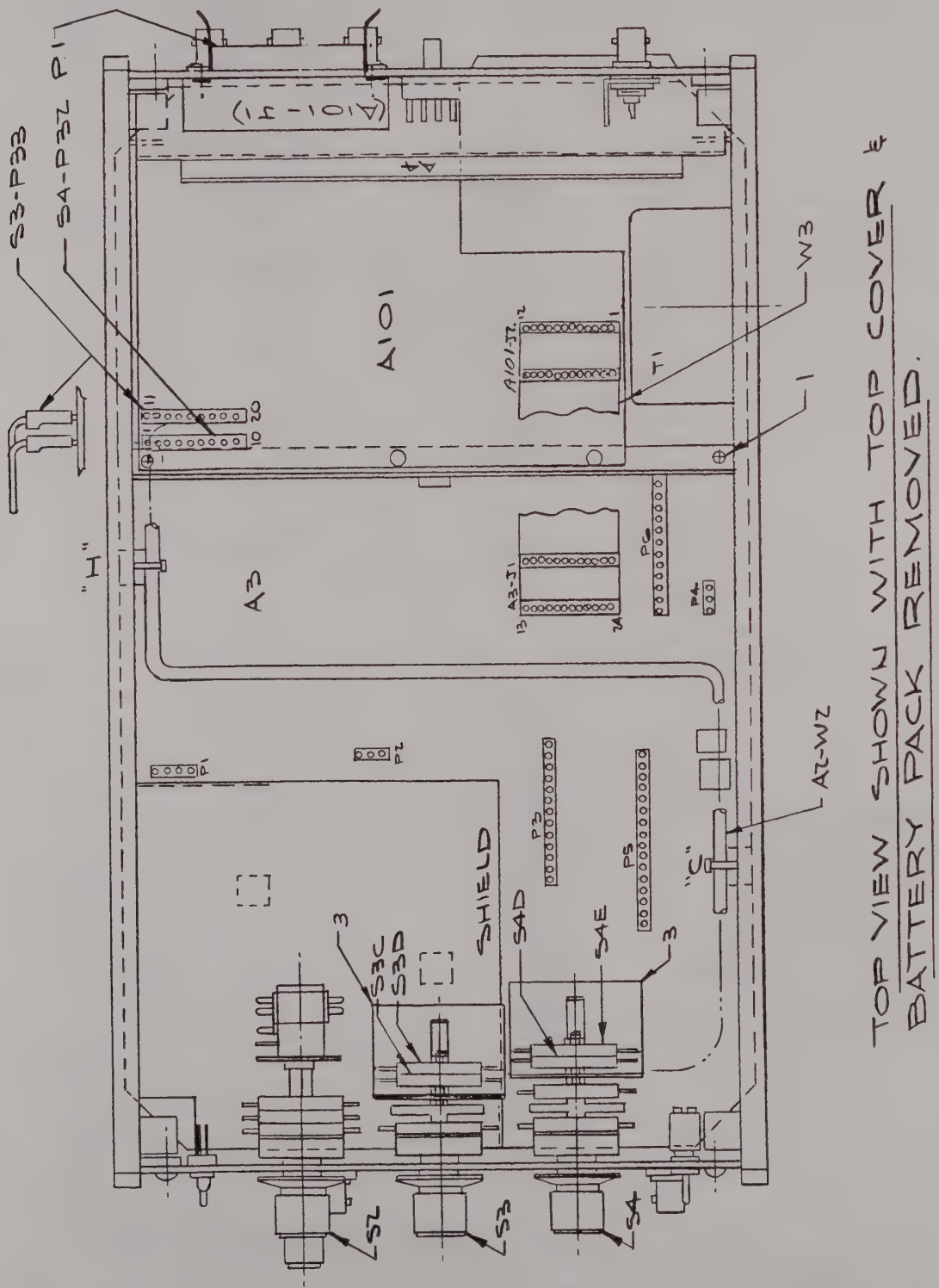
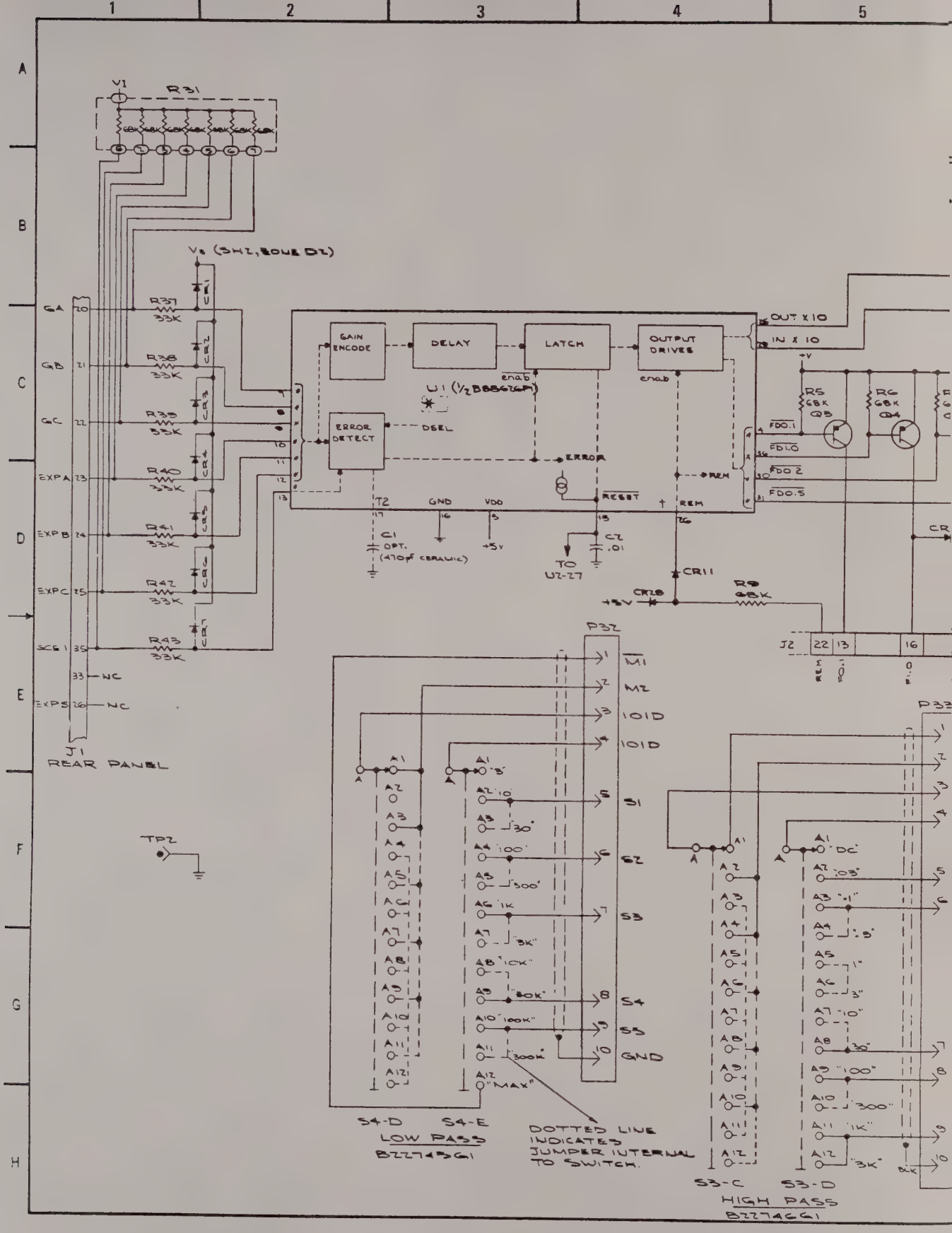
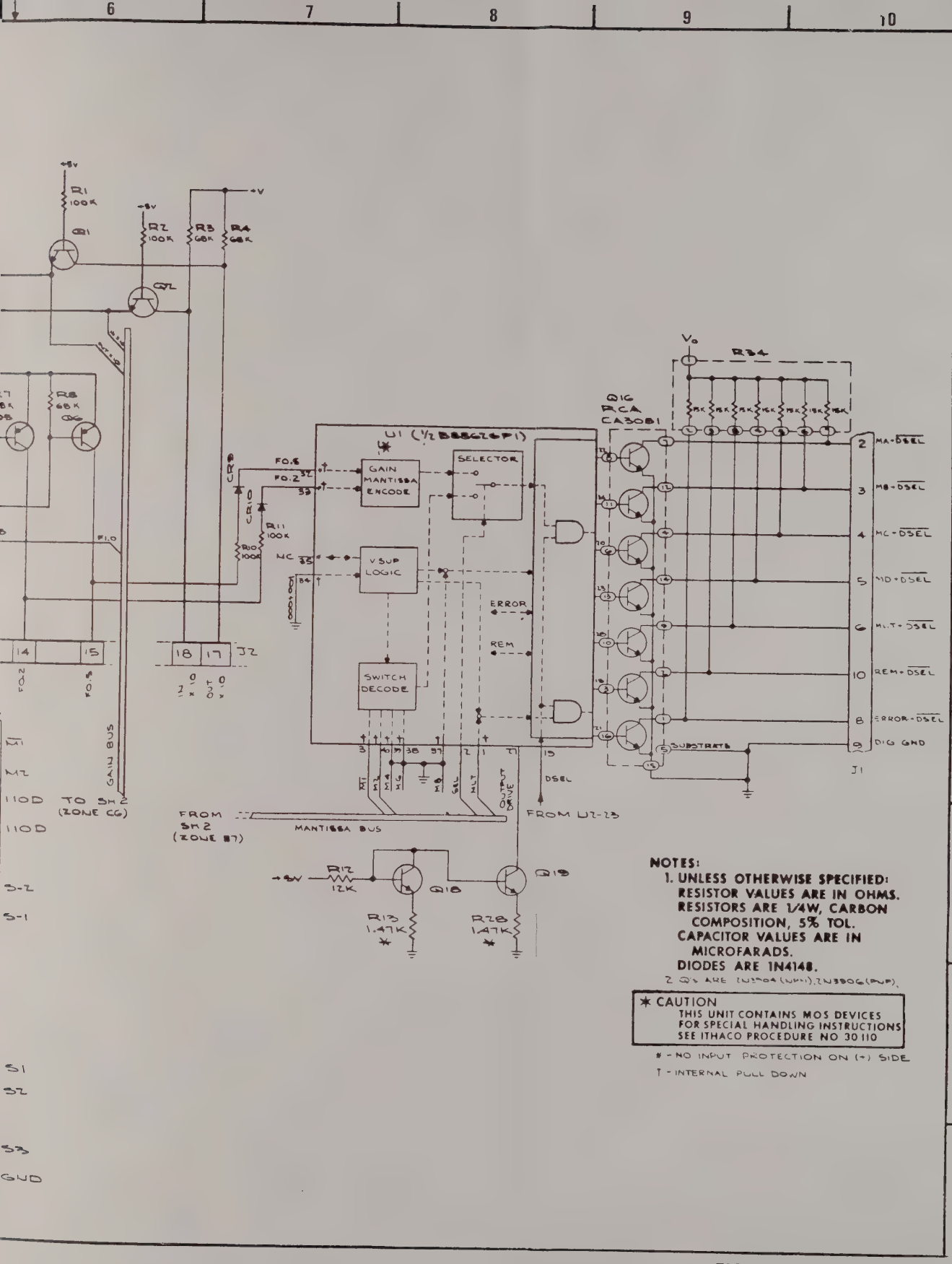


FIGURE 9.11 INSTALLATION INSTRUCTIONS – MODEL 1201-06 REMOTE PROGRAMMING OPTION – SHEET 3


1
2
3
4
5
A
B
C
D
E
F
G
H
V1
R31
V2 (3HZ, SQUARE)
GA
GB
GC
EXPA
EXPB
EXPC
SCS
EXPS
NC
NC
R37
R38
R39
R40
R41
R42
R43
33K
J1
REAR PANEL
GAIN ENCODE
DELAY
LATCH
OUTPUT DRIVES
OUT X10
IN X10
U1 (½ BBBG26P)
enab
ERROR DETECT
DSEL
ERROR
REM
RESET
T2
GND
VDD
+5V
C1
OPT.
(470pF CERAMIC)
C2
.01
TO U2-27
CR11
CR10
+12V
R9
68K
R5
68K
Q3
R6
68K
Q4
FDO.1
FDO.0
FDO.2
FDO.5
J2
P32
M1
M2
101D
101D
S1
S2
S3
S4
S5
GND
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
"3"
"10"
"30"
"100"
"300"
"1K"
"3K"
"10K"
"30K"
"100K"
"300K"
"MAX"
S4-D S4-E
LOW PASS
B2274561
DOTTED LINE INDICATES JUMPER INTERNAL TO SWITCH.
P33
"DC"
".03"
".1"
".3"
"1"
"3"
"10"
"30"
"100"
"300"
"1K"
"3K"
S3-C S3-D
HIGH PASS
B2274661
TP2



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   RESISTOR VALUES ARE IN OHMS.
   RESISTORS ARE 1/4W, CARBON COMPOSITION, 5% TOL.
   CAPACITOR VALUES ARE IN MICROFARADS.
   DIODES ARE 1N4148.

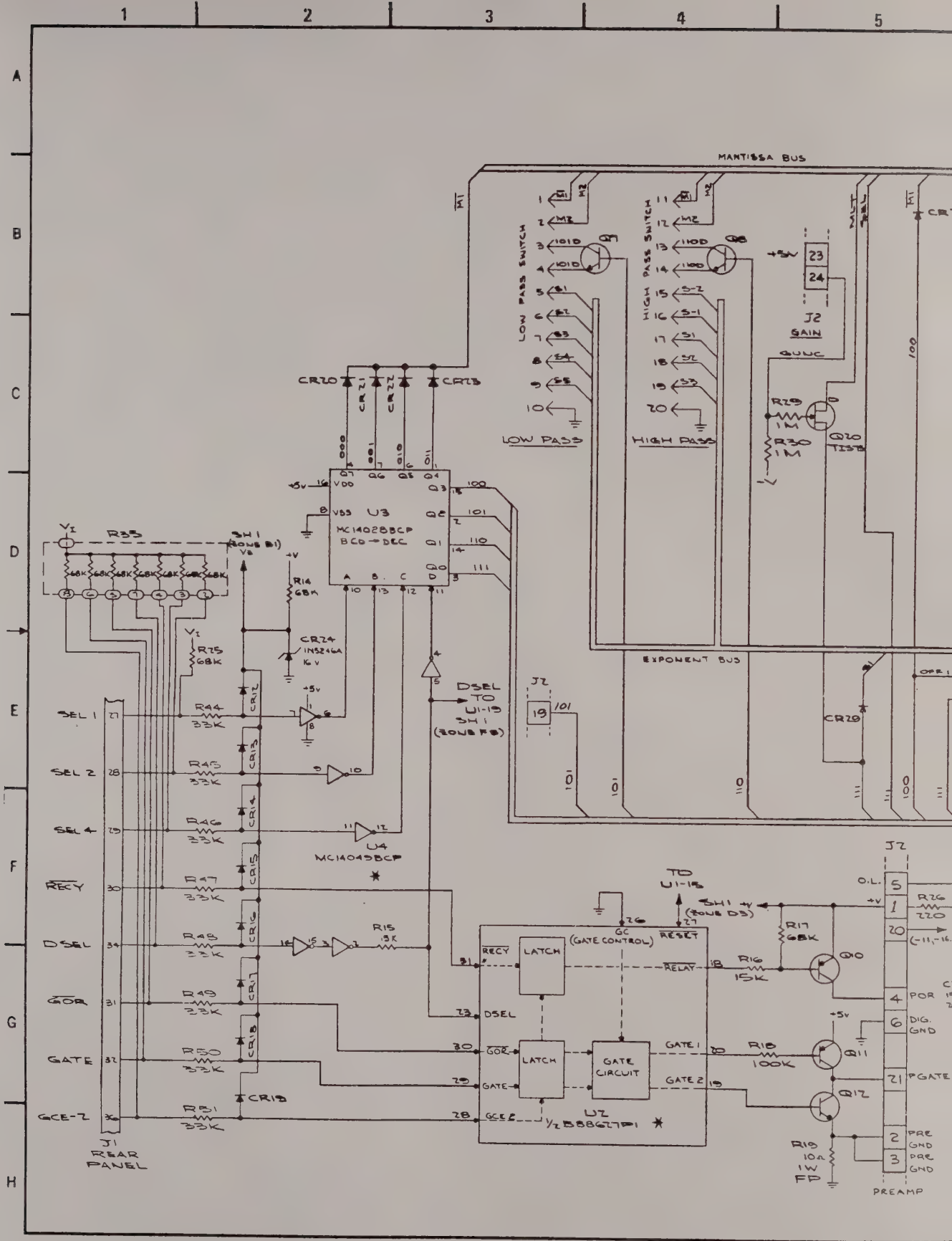
2 Q's ARE (NPN), 2N3906 (PNP).

✱ CAUTION
THIS UNIT CONTAINS MOS DEVICES
FOR SPECIAL HANDLING INSTRUCTIONS
SEE ITHACO PROCEDURE NO 30110

✱ - NO INPUT PROTECTION ON (+) SIDE

† - INTERNAL PULL DOWN

FIGURE 9.12
SCHEMATIC – REMOTE PROGRAMMING OPTION – SHEET 1
MODEL 1201 – OPTION 06



ITHACO DWG D42130, SH 2, REV D, 7/80

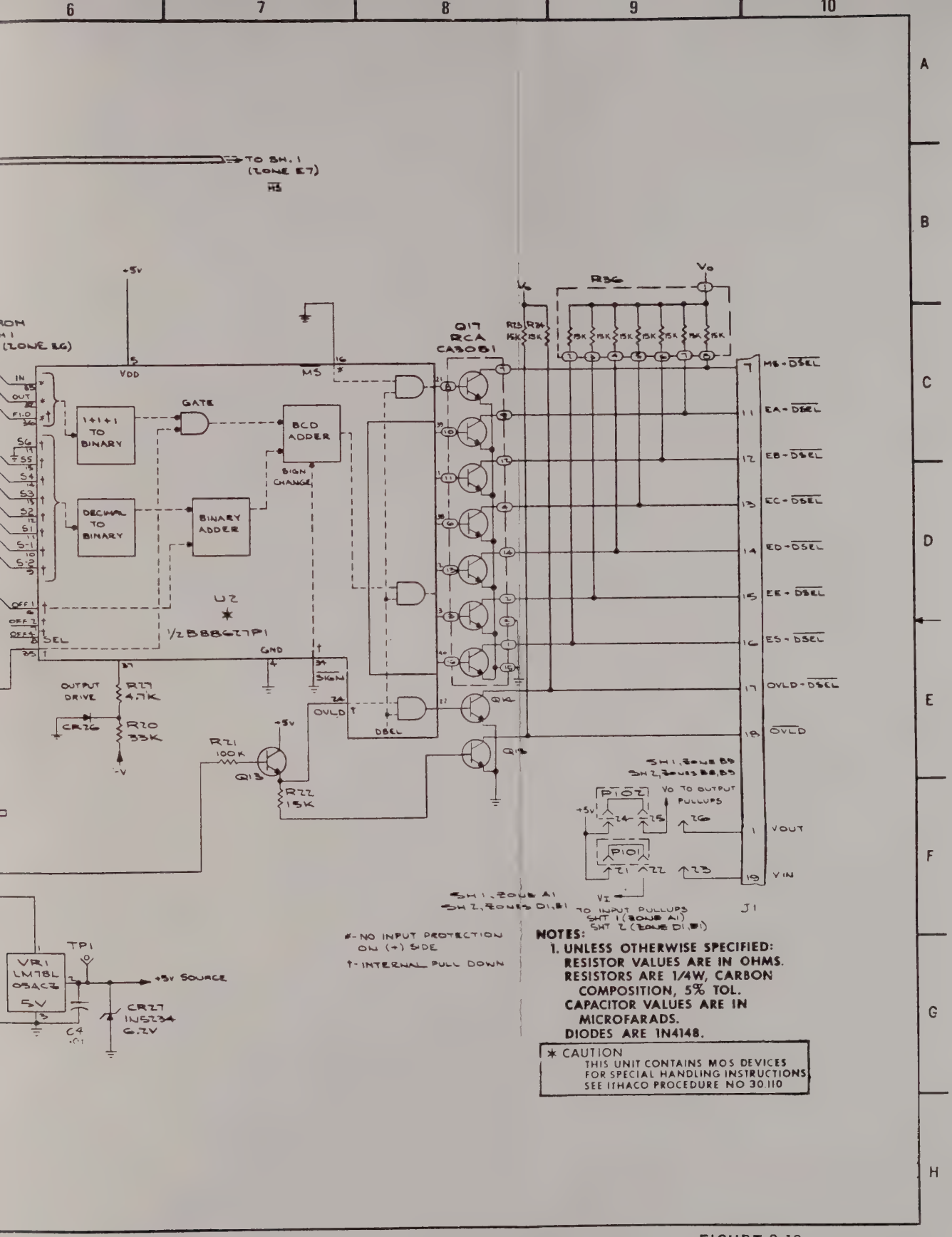


FIGURE 9.13
SCHEMATIC – REMOTE PROGRAMMING OPTION – SHEET 2
MODEL 1201 – OPTION 06

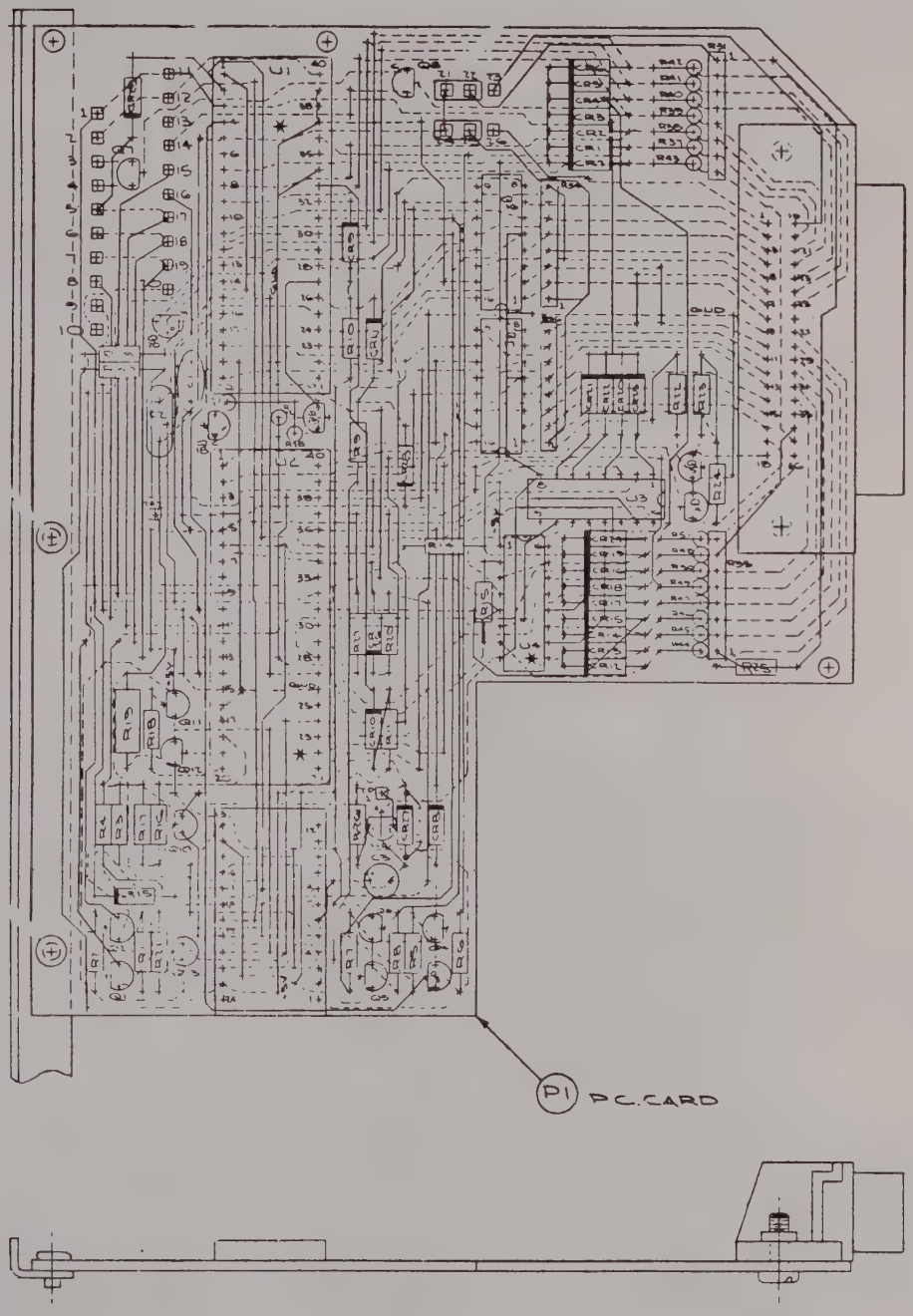


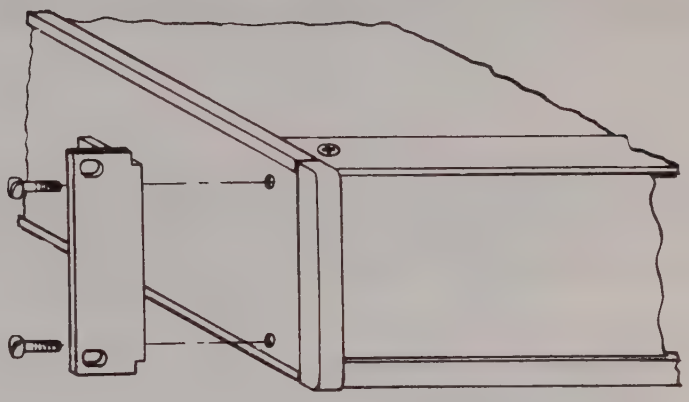
FIGURE 9.14 ASSEMBLY – REMOTE PROGRAMMING OPTION – MODEL 1201 – OPTION 06

ITHACO DWG D42164, SH 1, REV C, 12/80

INSTALLATION INSTRUCTIONS FOR ITHACO RACK MOUNTING KITS RM–1 AND RM–2

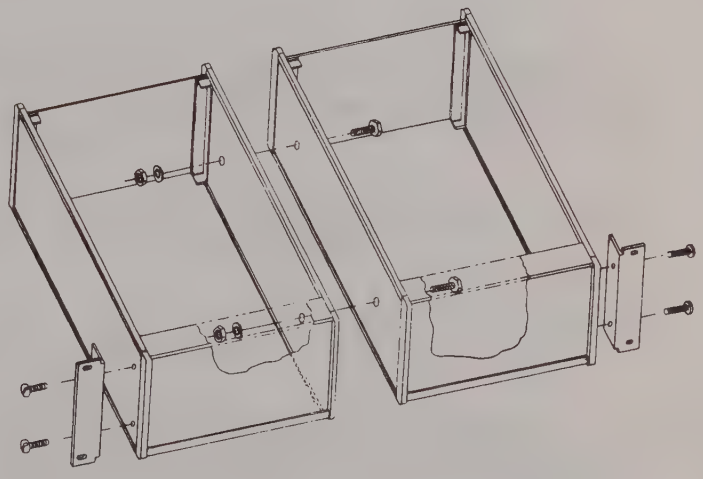
RM–1 FOR 17'' WIDE FULL RACK CHASSIS:

Remove the two screws at the front of each side cover. Place mounting ears of the RM–1 kit in place and secure using the screws previously removed.



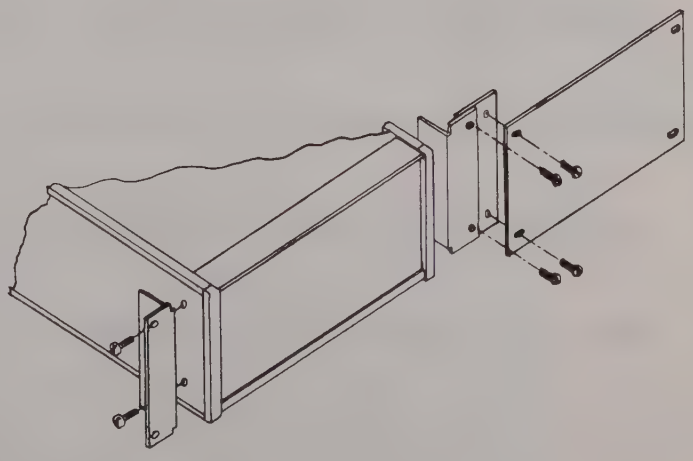
RM–1 FOR TWO 8½'' WIDE HALF RACK CHASSIS:

Remove opposite side covers from each unit. Remove top covers from each unit, secure the units together side by side, using nuts and bolts supplied. Replace the top covers, attach mounting ears in the same manner as a full rack unit.



RM–2 FOR A 8½'' WIDE HALF RACK UNIT

Remove the two screws at the front of each side cover. Place mounting ears in place and secure, using the screws previously removed. Attach extender plate to mounting ear on the desired side of the unit, secure using the threaded nut bar and hardware supplied.



RECOMMENDED HANDLING PROCEDURES FOR MOS DEVICES

ITHACO

GENERAL

MOS (Insulated Gate) devices, due to their extremely high input resistance, are subject to potential damage by the accumulation of excess static charge. To avoid possible damage to the devices during handling, testing, or actual operation, these procedures are recommended:

NOTE: Dry weather (relative humidity less than 30%) tends to multiply the accumulation of static charges on any surface. In a low humidity environment, the handling precautions take on added importance and should be adhered to without exceptions.

PROCEDURE

A. The leads of the devices should be in contact with a conductive material except when being tested or in actual operation, to avoid the build-up of static charge.

   1. The conductive material may be a conductive foam, metal foil, conductive rings or other suitable material.

B. Devices should not be inserted in non-conductive containers such as conventional styrofoam, plastic bubble paper, or trays.

C. When devices are removed from their conductive material, the hand being used should be grounded by a metal wrist strap which has a 1 megohm resistor in series with the wire between the strap and ground.

D. All soldering iron tips, test equipment, tools and fixtures must be grounded. Table tops and work surfaces should be conductive and grounded.

E. All grounds must be common and should be made as close together as possible.

F. Devices should not be inserted into or removed from circuits with the power on.

G. Signals should not be applied to the inputs while the device power supply is off.

Condensed from ITHACO MOP 30.110, June, 1978

WARRANTY

ITHACO Inc. warrants each instrument to be free of defects in material and workmanship for a period of one year after shipment to the original purchaser; batteries are specifically excluded. Liability under this warranty is limited to repairing or adjusting any instrument returned to the factory for that purpose. The warranty of this instrument is void if the instrument has been modified other than in accordance with written instructions from ITHACO, or if defect or failure is judged by ITHACO to be caused by abnormal conditions of operation, storage or transportation.

This warranty is subject to verification by ITHACO, that a defect or failure exists, and to compliance by the original purchaser with the following instructions:

1. Before returning the instrument, notify ITHACO with full details of the problem; include model number and serial number of the instrument involved.

2. After receiving the above information, ITHACO will give you shipping instructions or service instructions. After receipt of shipping instructions, ship the instrument to ITHACO. Full liability for damage during shipment is borne by the purchaser. It is recommended that instruments shipped to us be fully insured and packed surrounded by at least 2 inches of shock-absorbing material.

ITHACO reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

This warranty is expressly in lieu of all other obligations or liabilities on the part of ITHACO, and ITHACO neither assumes, nor authorizes any other person to assume for it, any liability in connection with the sales of ITHACO instruments.

ITHACO INC.
735 W. Clinton Street
Ithaca, New York 14850
Telephone: 607-272-7640

LAST ONE!

Customer gets a copy

Return this to the floor

LAST ONE!

Ithaco Model 1261